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Database of Low-e Storm Window Energy Performance across U.S. Climate Zones

September 2014

KA Cort
TD Culp

U.S. DEPARTMENT OF ENERGY

Prepared for the U.S. Department of Energy
under Contract DE-AC05-76RL01830

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KA Cort, Project Lead
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[1] Birch Point Consulting, LLC, La Crosse, Wisconsin.

Summary

The energy savings and cost effectiveness of installing low-emissivity (low-e) storm windows over existing windows in residential homes was evaluated across a broad range of U.S. climate zones. This work expands upon previous case studies, as well as modeling analysis performed in support of the state of Pennsylvania's efforts to add low-e storm windows to its list of "priority" Weatherization Assistance Program measures. Calculations of energy savings and cost effectiveness of low-e storm windows were conducted with two software platforms: the National Energy Audit Tool (NEAT) used by weatherization programs and RESFEN software used to compare the annual energy performance of different window options in single-family homes.

Both exterior and interior low-e storm windows/panels installed in conjunction with three different primary window types were evaluated in 22 different cities across all eight International Energy Conservation Code climate zones. Both regular low-e glass and solar control low-e glass, which decreases solar heat gain in addition to decreasing heat transfer through the glass, were included in the analysis. The NEAT analysis used 39 model homes, and the RESFEN analysis used 2 model homes.

Low-e storm windows were found to always be cost effective when installed over single-pane windows in climate zones 3 through 8, and over double-pane, metal-framed windows in climate zones 4 through 8. The savings-to-investment ratio (SIR) ranged from 1.2 to 3.2 across the different locations analyzed. The average source energy savings ranged from 24 to 36% with a simple payback period of 4.7 to 12.9 years across climate zones 4 through 8. The use of solar-control, low-e storm windows is recommended in climate zone 3, and may also be considered in warmer parts of zone 4 where cooling degree days exceed heating degree days. The use of regular low-e storm windows is recommended in zones 4 through 8.

Low-e storm windows also were found to "qualify" as weatherization cost-effective measures (based on SIR greater than 1) and would therefore be recommended for installation over double-pane wood or vinyl-framed windows in climate zones 6 through 8, and in eastern parts of zone 5 where higher heating fuel costs exist. The SIR ranged from 1.1 to 1.9 across the different locations analyzed. The average source energy savings ranged from 16 to 19% with a simple payback period of 11 to 14 years.

All analyses were conducted assuming the model home was heated either with a natural gas furnace or electric heat pump depending on location. A sensitivity analysis was performed to examine the impact on the SIR when the assumed heating equipment, fuel sources, fuel costs, and baseline air leakage of the primary window were changed. When propane heating, electrical-resistance heating, or higher than average heating fuel costs are present, the SIR for installing a low-e storm windows increases. The SIR also is significantly higher for installations over primary windows with higher air leakage than what was assumed in this study (3 cfm/ft^2 for single-pane base windows, 1 cfm/ft^2 for double-pane base windows).

In addition, the incremental cost for using low-e glass versus clear glass was found to be cost effective in all climate zones over all window types with an average payback period of 2 to 5 years. This indicates that, when a homeowner chooses to install a storm window or interior window panel for reasons other than just energy savings (e.g., increased comfort, noise reduction, window protection, reduced air leakage, etc.), the use of low-e glass is recommended regardless of location.

Acronyms and Abbreviations

AFUE	annual fuel utilization efficiency
DOE	U.S. Department of Energy
HSPF	heating seasonal performance factor
IECC	International Energy Conservation Code
LBNL	Lawrence Berkeley National Laboratory
Low-e	low emissivity
Mcf	1000 cubic feet
NEAT	National Energy Audit Tool
RECS	Residential Energy Consumption Survey
SEER	seasonal energy efficiency ratio
SHGC	solar heat gain coefficient
SIR	savings-to-investment ratio

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1.0 Introduction and Background

This report describes work conducted in support of the Emerging Technologies Low-e Storm Windows Task 5.3: Create a Database of U.S. Climate-Based Analysis for Low-e Storm Windows. The scope of the overall effort is to develop a database of energy savings and cost effectiveness of low-emissivity (low-e) storm windows/panels in residential homes across a broad range of U.S. climates. The database expands upon previous calculations for Pennsylvania's Weatherization Assistance Program and storm window case studies to develop regionally based savings information for additional locations and climates. This report and calculations will be made publicly available through the Building America Solution Center and other outreach activities. This research can provide U.S. Department of Energy (DOE), national and regional utilities, and state weatherization programs with important data showing the potential energy savings low-e storm windows can contribute to energy retrofits in existing buildings.

A series of laboratory tests have proven that standard low-e storm windows save energy at the component level. The performance improvements have been validated with field tests and case studies supported by DOE's Emerging Technologies team. The combination of results from these laboratory and field tests, as well as the data collected as part of these previous efforts, helped inform the National Energy Audit Tool (NEAT) and RESFEN modeling assumptions used in this study. These case studies have been summarized in the report entitled *Task Plan in Support of Emerging Technology Task ET-WIN-PNNL-FY13-01_5.1: Create a Database of U.S. Climate-Based Analysis for Low-e Storm Windows*, which was completed in an earlier phase of this overall modeling task (Hefty et. al. 2013).

In addition to the field tests and case studies, prior calculations of potential energy savings included a DOE-funded joint effort[1] for the state of Pennsylvania using NEAT to support adding low-e storm windows to the state's weatherization measure priority list, and previous calculations performed by Birch Point Consulting under DOE Office of Energy Efficiency and Renewable Energy award #DE-EE0004015 using RESFEN software to estimate savings in different cities. Developed by Oak Ridge National Laboratory for DOE's Office of Weatherization and Intergovernmental Programs, NEAT is the primary approved software designated for state weatherization programs. RESFEN is a DOE-based building simulation program developed by Lawrence Berkeley National Laboratory (LBNL) that was specifically designed to compare the annual energy performance of different fenestration options in single-family homes, and it is used as the basis of the ENERGY STAR® program for windows, doors, and skylights. It is valuable to have calculations from both platforms to address the different audiences that will use the data (utilities, weatherization programs, federal energy-efficiency programs, consumers, etc.). Gaps in both existing data sets were identified, and additional NEAT and RESFEN analyses were proposed, specifically adding cities to cover additional U.S. climate zones, and including data for low-e storm windows installed over additional primary window types (single or double pane, wood or metal frame, etc.) The purpose of this database effort and documentation report is to fill in these gaps by modeling low-e storm window performance over a broad range of climate zones with a variety of baseline model home characteristics. This report provides a summary of the final results of the NEAT and RESFEN calculations, including general observations and recommendations regarding the use of low-e storm windows and panels.

[1] Joint effort between DOE's BTP and DOE's Office of Weatherization and Intergovernmental Programs (OWIP), Pennsylvania's Department of Community and Economic Development, LBNL, Energetics, and Birch Point Consulting.

2.0 NEAT Analysis of Low-e Storm Windows

During 2010 and 2011, an analysis was conducted to help the state of Pennsylvania determine the energy savings potential of adding the installation of low-e storm windows to its weatherization measure priority list. This was a joint effort of DOE, the Pennsylvania Department of Community and Economic Development, Energetics, LBNL, and Birch Point Consulting.

The prior NEAT analysis included four cities across Pennsylvania, 37 model home types, and two primary window types (single-pane wood frame, and double-pane metal frame). The 37 model homes were selected from a data set, prepared by Dalhoff Associates with the intention of covering a wide range of older existing housing commonly encountered in weatherization programs. Different insulation scenarios were included for the following home types: detached masonry, semi-detached masonry, row-house masonry, detached wood frame (e.g., slab, crawl space, unconditioned basement, conditioned basement, etc.), cape-cod wood frame, semi-detached wood frame, row-house wood frame, and exposed floor (Dalhoff 2010).

The primary result of the NEAT analysis that examined a particular weatherization measure comes in the form of savings-to-investment ratio (SIR), because a SIR greater than 1 is required to qualify as a weatherization measure using state and federal funding. NEAT also can be used to provide estimates of site energy savings, rankings relative to other weatherization measures, and the maximum cost that a weatherization measure could be while still producing a SIR greater than 1. Simple payback also can be calculated; although, in the case of storm windows, only part of the air-infiltration savings is captured in the storm window listing within the NEAT[1] calculation results (provided in Appendix A). Therefore, either a portion of the overall home air-infiltration savings also needs to be credited to storm windows in the calculation, or the payback period will be somewhat overstated.

The analysis for Pennsylvania showed that low-e storm windows would qualify as a cost-effective weatherization measure. The SIR values ranged from 1.4 to 2.2 when low-e storm windows were used over single-pane, wood-framed windows and ranged from 1.3 to 2.1 when they were used over double-pane, metal-framed windows. As a result, the state of Pennsylvania added low-e storm windows to its weatherization measure selection priority list for single-family homes in 2010 (Zalis et al. 2010; Krigger 2011).

2.1 NEAT Analysis and Methodology

The NEAT analysis presented in this report expands on the previous weatherization work to cover more locations in different states and climates. As outlined below, the same general methodology used in for Pennsylvania was used for this expanded coverage.

[1] NEAT simulates heating, cooling, and air infiltration reductions separately and attributes whole home reductions in air infiltration to a number of different air-sealing weatherization measures. Based on case studies summarized in Hefty et. al. (2013), whole home air leakage can be reduced by an average of 10 to 15% just by adding storm windows, and when combined with other weatherization measures, the whole home leakage is reduced by 20 to 40%. Therefore, assigning an estimate of one-third of air-infiltration reductions (which was assumed in this study) to be attributed to storm windows most likely underestimates the full infiltration benefits of storm windows and would be considered a conservative attribution.

- NEAT calculations were run for a total of 20 cities across seven International Energy Conservation Code (IECC) climate zones (no weather files were available in NEAT format for climate zone 8, which is only found in northern Alaska). Figure 2.1 is a map of IECC climate zones and the locations of cities included in this analysis. The cities are listed out in Table 2.1 and Table 2.2.
- Low-e storm windows were evaluated based on installations of three different primary window types (i.e., single-pane wood or vinyl frame, double-pane wood or vinyl frame, and double-pane metal frame, all with clear glass). This adds clear double-pane wood and double-pane vinyl windows to the windows addressed in the Pennsylvania NEAT analysis. Single-pane metal windows were not included, but because the SIR will always be higher, they will be qualified as weatherization measures where single-pane wood/vinyl windows or double-pane metal windows are used. This is because the single-pane, metal-framed window will have the worst U-factor (i.e., heat transfer coefficient) of all the primary window types, and therefore, the relative improvement in U-factor and energy performance from adding a low-e storm window will be even higher than with the other primary window types.

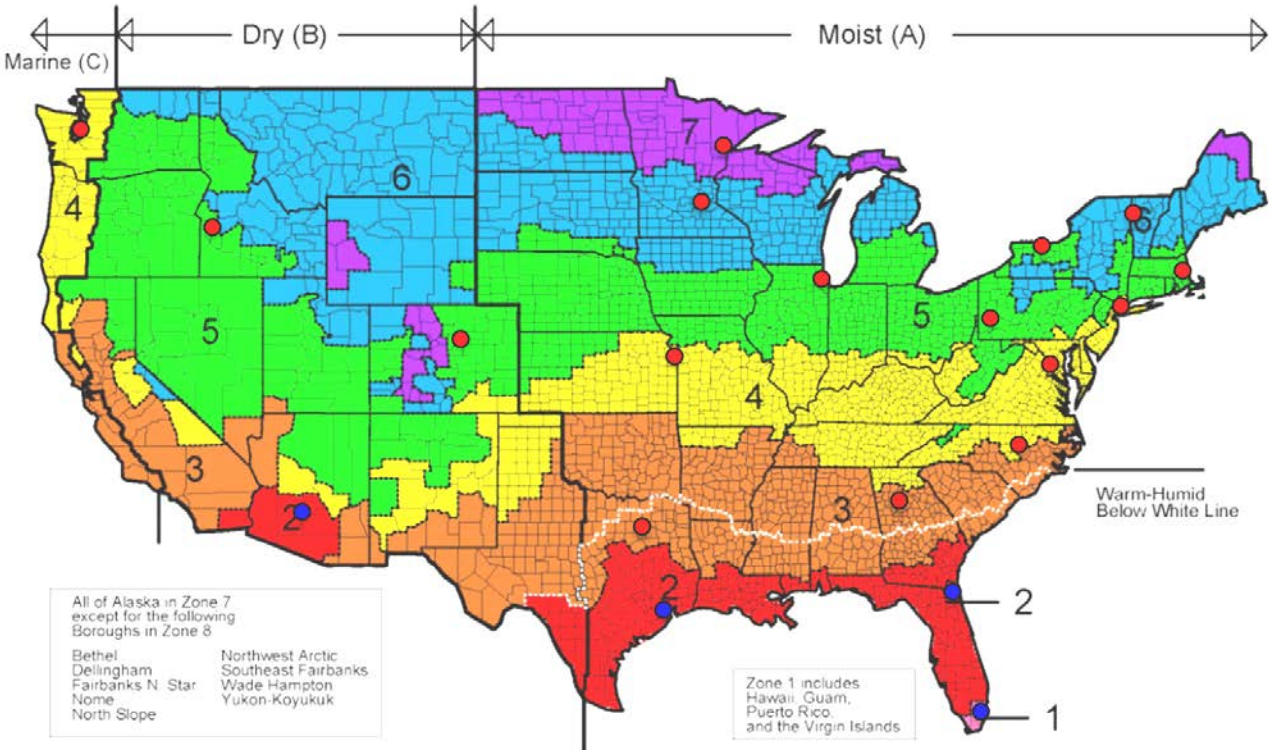

Figure 2.1. IECC Climate Zone Map

- The method used in this analysis was different from the Pennsylvania NEAT analysis as follows:
  - The latest NEAT version (i.e., 8.9.0.5 released in February 2012) was used. This version includes updated fuel escalation rates and updated prices for other weatherization measures.
  - Two additional homes were added to the data set that was used in the Pennsylvania NEAT analysis (Dalhoff 2010) to capture a broader range of insulation levels. This resulted in total of 39 model homes, where the two additional homes are assumed to have insulation throughout the

home (R11 walls, R19 attic, R11 floor) and one is characterized as a wood-frame, vented crawl space home, while the other is a masonry home.

  - For the set of homes used in the Pennsylvania NEAT analysis (Dalhoff 2010), only one-quarter of the floor space was assumed to be air conditioned using less efficient room/window air-conditioner units, and no air conditioning was used in the rest of the home. These characteristics are typical of weatherization homes in Pennsylvania and many other locations, but data from the DOE Residential Energy Consumption Survey (RECS) show that it is more common to have central air conditioning in the Midwest, South-Central, and Southern regions (DOE-EIA 2009). Therefore, the homes were modified to include a central air conditioner (SEER 8) in climate zones 1 through 3 as well as in the warmer zone 4 locations where cooling degree days exceed heating degree days (i.e., Raleigh, North Carolina, Washington, D.C.).
  - RECS data also show that heat pumps are more common than natural gas furnaces in southern locations, so the homes were modified to use a heat pump with 6.8 HSPF in climate zones 1 and 2 and certain zone 3 locations rather than an 80% AFUE natural gas furnace (DOE-EIA 2009).
  - The natural gas and electricity prices used were based on location using 2012 state average prices taken from the DOE Energy Information Administration *Natural Gas Monthly and Electric Power Monthly* reports (DOE-EIA 2013).

- The assumed storm window properties are described below:
  - *Low-e Glass*. Storm window properties were based on the characteristics of commercially available low-e storm windows. Standard low-e (0.157 emissivity, 0.75 center-of-glass solar heat gain coefficient [SHGC]) was evaluated in all zones. Solar-control low-e (0.166 emissivity, 0.54 center-of-glass SHGC) was evaluated in climate zones 1 through 3 and certain warmer locations in zone 4 where cooling degree days exceed heating degree days (Raleigh, North Carolina, and Washington D.C.).
  - *Product Cost*. Product and installation costs were primarily based on analysis performed as part of the Pennsylvania NEAT study (Dalhoff 2010). For this analysis, material costs were assumed to be \$7.85/ft^2 of window area, plus an average of \$30 per window was assumed for installation expenses. Do-it-yourself installations (which account for 80% of installations) cost only ~\$2 per window, whereas contractor installation can cost \$60 per window but will vary depending on location. A weighted average cost of \$14 per window could have been used based on this information (the Pennsylvania analysis assumed \$15 per window installation costs), but because of the high variability, a cost of \$30 was used to be conservative. If the lower installation cost is thought to be more applicable (e.g., for a utility program in which consumers will primarily do self-installation), the SIR results will further increase.
  - *Lifetime*. Twenty years for this study. Fifteen years was used initially in the Pennsylvania analysis, but based on updated information including manufacturer warranties, 20 years is more accurate (Cort 2013).

In addition to the main calculations, some additional runs were made to explore the impact of natural gas fuel pricing and different primary window air leakage levels. Overall, approximately 4240 model runs were performed.

2.2 NEAT Results

The average SIR for using low-e storm windows installed over different primary window types in different cities/climate zones is shown in Table 2.1. NEAT SIR output is only provided for cities with SIRs greater than 1. Each value is the average SIR across the 39 different homes for that particular location and window type. The detailed SIR results for each city and home type are provided in Appendix A. The site energy percentage savings and simple payback period for a representative home are shown in Sensitivity: A sensitivity analysis was performed based on independent changes in single variables. In general, the largest variables affecting whether low-e storm windows are cost effective are location (climate), heating fuel cost, existing window tightness, and storm window cost. Factors that have less effect include home type, window area, and orientation.

- *Heating fuel price* has a large impact on SIR—as much as location/climate, and more than home type. This is particularly noticeable in the Midwest and Rocky Mountains regions where the cost of natural gas has decreased in recent years and is much cheaper than in the Northeast and Southeast. State average natural gas prices vary significantly from approximately $8 to $16/Mcf (DOE-EIA 2013). As an example, Figure 2.2 shows the SIR as a function of natural gas price for low-e storm windows in one home type in Chicago. At the current low cost of $8.22/Mcf, the SIR is 1.4, but it increases by approximately 0.3 for every $2/Mcf increase in price (with a corresponding decrease in payback period).

Table 2.2, although simple payback should be viewed with a cautionary note. In the case of storm windows, only part of the air-infiltration savings are captured under the storm window listing within the NEAT results, so either a portion of the overall home air-infiltration savings needs to also be credited to storm windows in the calculation, or the payback period will be somewhat overstated.[1] An estimate of the payback including the additional air-infiltration savings is also included.

The following general points and trends were observed:

- In climate zones 3 through 8, low-e storm windows are always cost effective (SIR >1) when installed over single-pane windows and double-pane, metal-framed windows. The SIR values range from 1.2 to 3.2 across the different locations analyzed.
- Low-e storm windows also can be cost effective when installed over double-pane wood or vinyl-framed windows in many locations of climate zones 3 through 8, but SIR values depends on the climate, local fuel cost, and storm window glass type. The SIR values range from 1.1 to 1.9 across the different locations analyzed.
- Under the following conditions, the SIR increases:
  - In colder climates
  - By using solar-control, low-e glass in warmer climates (zone 3 as well as warmer cities in zone 4 where cooling degree days exceed heating degree days)
  - In locations with higher heating fuel costs
  - Over existing windows that exhibit the highest air leakage.

[1] More detail on the structure and content of the NEAT can be found at the Weatherization Technical Assistance Center (http://www.waptac.org/) and in related manuals (Gettings 2006).

- In climate zones 1 and 2, storm windows with solar-control, low-e glass can be cost effective, although pragmatically, other low-cost, solar-control measures like solar screens and films will have higher SIR values.
- The analysis was performed with either a natural-gas furnace or electrical heat pump depending on location. For homes using propane or electrical resistance heating, the SIR of low-e storm windows will be even higher because the effective heating fuel cost and savings from using low-e storm windows will be higher. The reverse is also true; households with more efficient heating equipment and low heating fuel costs would likely have a relatively lower SIR resulting from storm window installations.

Table 2.1. Average SIR for Low-e Storm Windows Calculated by NEAT

		Average SIR of Low-e Storm Windows Used Over Different Primary Window Types					
		Standard Low-e Glass			Solar Control Low-e Glass		
Climate Zone	City, State	Single-Pane, Wood- or Vinyl-Framed Window	Double-Pane, Metal-Framed Window	Double-Pane, Wood- or Vinyl-Framed Window	Single-Pane, Wood- or Vinyl-Framed Window	Double-Pane, Metal-Framed Window	Double-Pane, Wood or Vinyl-Framed Window
7	Duluth, MN	2.1	2.0	1.3			
6 A	Burlington, VT	3.2	3.1	1.9			
6 A	Minneapolis, MN	1.6	1.6	1.2			
5 A	Boston, MA	2.3	2.2	1.5			
5 A	Rochester, NY	2.8	2.6	1.8			
5 A	Pittsburgh, PA	1.8	1.7	1.2			
5 A	Chicago, IL	1.4	1.4	--			
5 B	Denver, CO	1.3	1.3	--			
5 B	Boise, ID	1.3	1.2	--			
4 A	New York, NY	2.1	2.0	1.4			
4 A	Washington, DC	1.5	1.5	1.1	1.6	1.6	1.2
4 A	Raleigh, NC	1.2	1.2	--	1.3	1.3	1.0
4 A	Kansas City, MO	1.5 (1.7)[(a)]	1.4 (1.7)[(a)]	1.0 (1.2)[(a)]			
4 C	Seattle, WA	1.4	1.4	--			
3 A	Atlanta, GA	1.2	1.2	--	1.4	1.3	1.2
3 A	Dallas, TX	1.3	1.2	--	1.5	1.5	1.3
2 A	Jacksonville, FL	--	--	--	1.2	1.2	--
2 A	Houston, TX	--	--	--	1.2	1.2	--
2 B	Phoenix, AZ	--	--	--	--	--	--
1 A	Miami, FL	--	--	--	1.2	1.2	1.1

-- = SIR <1 under the assumed fuel and product costs.
Gray cells not evaluated.
(a) Second value for Kansas City shows whole home air conditioned versus one-quarter of floor area air conditioned.

- Sensitivity: A sensitivity analysis was performed based on independent changes in single variables. In general, the largest variables affecting whether low-e storm windows are cost effective are location

(climate), heating fuel cost, existing window tightness, and storm window cost. Factors that have less effect include home type, window area, and orientation.

– *Heating fuel price* has a large impact on SIR—as much as location/climate, and more than home type. This is particularly noticeable in the Midwest and Rocky Mountains regions where the cost of natural gas has decreased in recent years and is much cheaper than in the Northeast and Southeast. State average natural gas prices vary significantly from approximately $8 to $16/Mcf (DOE-EIA 2013). As an example, Figure 2.2 shows the SIR as a function of natural gas price for low-e storm windows in one home type in Chicago. At the current low cost of $8.22/Mcf, the SIR is 1.4, but it increases by approximately 0.3 for every $2/Mcf increase in price (with a corresponding decrease in payback period).

Table 2.2. Percent Site Energy Savings, SIR, and Simple Payback for Low-e Storm Windows in a Representative Wood-Framed Home (Home code WFVC6[1]) as Calculated by NEAT

		Results in WFVC6 Home from Adding Low-e Storm Windows (wood-framed home, vented crawlspace, R11 walls, R19 attic, R11 floor)					
		Standard Low-e Glass Over Single-Pane Wood/Vinyl Window			Solar Control Low-e Glass Over Single-Pane Wood/Vinyl Window		
Climate Zone	Location	% Site Energy Savings	SIR	Simple Payback in Years[(a)]	% Site Energy Savings	SIR	Simple Payback in Years[(a)]
7	Duluth, MN	19%	2.1	7.3 (5.7)			
6 A	Burlington, VT	19%	3.2	4.8 (3.8)			
6 A	Minneapolis, MN	19%	1.6	9.4 (7.3)			
5 A	Boston, MA	21%	2.3	6.8 (5.2)			
5 A	Rochester, NY	20%	2.8	5.6 (4.4)			
5 A	Pittsburgh, PA	19%	1.8	8.3 (6.6)			
5 A	Chicago, IL	20%	1.4	11.6 (8.9)			
5 B	Denver, CO	18%	1.3	13.2 (9.8)			
5 B	Boise, ID	18%	1.3	12.3 (9.2)			
4 A	New York, NY	21%	2.1	7.1 (5.5)			
4 A	Washington, DC	18%	1.5	9.9 (7.8)	16%	1.6	9.3 (7.4)
4 A	Raleigh, NC	16%	1.2	13.5 (10.6)	16%	1.3	12.3 (9.9)
4 A	Kansas City, MO	18%	1.7	8.9 (7.1)			
4 C	Seattle, WA	22%	1.4	10.7 (8.4)			
3 A	Atlanta, GA	16%	1.2	12.4 (9.7)	16%	1.4	11.2 (9.0)
3 A	Dallas, TX	13%	1.3	10.3 (8.1)	16%	1.5	8.5 (6.9)
2 A	Jacksonville, FL	--	--	--	12%	1.2	9.6 (7.7)
2 A	Houston, TX	--	--	--	12%	1.2	9.5 (7.3)
2 B	Phoenix, AZ	--	--	--	--	--	--
1 A	Miami, FL	--	--	--	10%	1.2	9.7 (7.0)

Payback will be shorter for leakier primary windows, higher fuel costs, or propane and electrical resistance heating.
-- = SIR <1 under the assumed fuel and product costs
Gray cells not evaluated.
(a) Second payback value in parentheses is if one-third of the air-infiltration cost savings is assigned to storm windows. This

[1] WFVCS6 is the code for a wood-framed home with a vented crawl space.

is just an estimate to help bracket the payback.

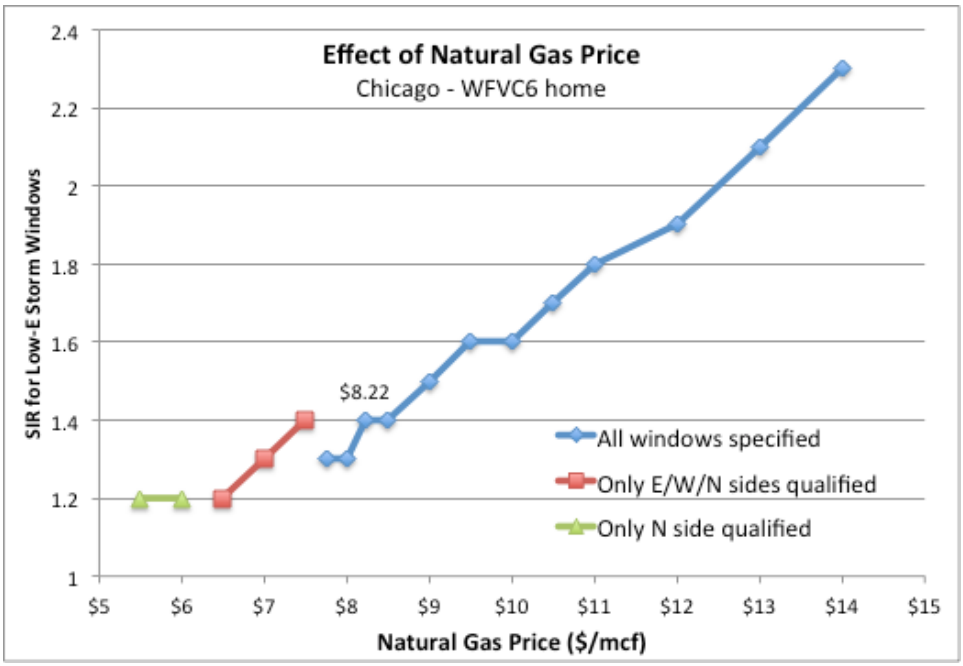

Figure 2.2. Effect of Natural Gas Price on the SIR of Low-e Storm Windows in Chicago

– The *air tightness of the existing window* also has a large impact on energy savings and whether the measure is cost effective. The leakier the existing window, the greater the SIR of adding low-e storm windows. NEAT defines five levels of air tightness for the existing window (very tight, tight, medium, loose, and very loose)[1] and provides descriptions to help the auditor assign the appropriate level (see Figure 2.3). The NEAT analysis was performed with a medium tightness, which should be conservative for most existing homes based on the NEAT definition. However, the SIR will increase (and the payback period will decrease) for existing windows that are leakier. As an example, Figure 2.3 shows the SIR for low-e storm windows as a function of existing window air tightness in one home type in Pittsburgh, Pennsylvania. With loose existing windows, which would not be uncommon in older homes, the SIR can increase by 0.8, and the payback period can decrease by over 2 years.

[1] Although specific measurable parameters (e.g., cfm/s.f.) are not associated with NEAT categories for air tightness, qualitative defintions are provided for auditing purposes. For example, "medium" tightness is described as "typical of older windows found in older homes." Deteriorating weatherstripping would be present, but no visible gaps. More information can be found in "Window Leakiness Guidelines" (ORNL 2009).

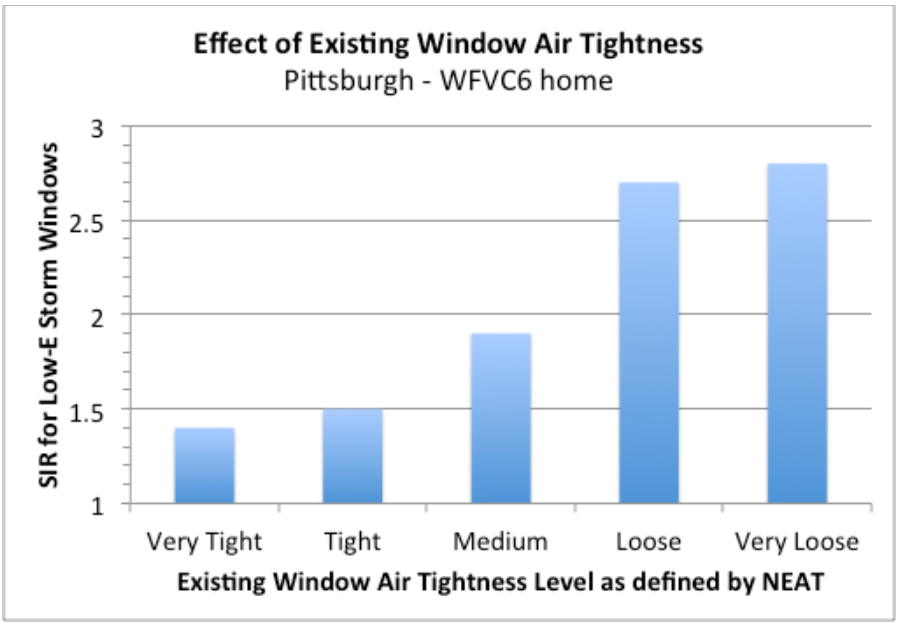

Figure 2.3. Effect of Existing Window Air Tightness on the SIR of Low-e Storm Windows in Pittsburgh, Pennsylvania

- The SIR of low-e storm windows does not heavily depend on *home type*. The percent energy savings will vary more based on the specific home, but the SIR is less sensitive. As seen in Appendix A, the SIR typically varies by only ±0.2 across all 39 home types for a given window type and city.
- Although counter-intuitive, *window area* does not affect the SIR significantly. Window area obviously affects the overall load, energy savings, and storm window cost, but because the cost and energy savings scale similarly with square footage, the SIR does not change much. When the window area was doubled in the WFVC6 home in Pittsburgh, the energy savings increased from 19 to 33% of the total home site energy use, but the SIR only changed from 1.9 to 1.8.
- The overall cost effectiveness does not vary dramatically with *orientation*. For the WFVC6 home in Pittsburgh, the SIR remained at 1.9 whether the home was oriented north/south (67% of glazing on the north and south) or oriented east/west. The cost effectiveness of windows on individual sides does vary because of the different beneficial or detrimental role of solar gain on the south versus west/east sides, but the overall SIR does not vary dramatically. (For example, the SIR for solar control low-e storm windows will be higher on the west and east sides than on the south side.)

Overall conclusions and recommendations based on both the NEAT and RESFEN analysis results are provided in Chapter 4.0.

3.0 RESFEN Analysis of Low-e Storm Windows

RESFEN is the standard software program used for calcuting the impact of windows on heating and cooling costs for new and existing residential homes. RESFEN allows you to enter housing characteristics (including window characteristics) and location information to represent the house type and climate zone of interest. RESFEN is frequently employed by utility energy-efficiency programs and ENERGY STAR to determine whether or not the residential fenestration performance of a given product is sufficient to meet program requirements.

3.1 RESFEN Analysis Background and Methodology

Birch Point Consulting performed previous unpublished RESFEN calculations in 2012 for two home types in 30 different cities across seven IECC climate zones. The two home types included an older, smaller, one-story 1800-ft^2 home, and a larger, newer, two-story 2300-ft^2 home. Exterior and interior low-e storm windows installed over one primary window type (single-pane, wood-frame window) were evaluated. In addition, some extra calculations were added in three cities for interior and exterior low-e storm windows installed over both single- and double-pane, wood- and metal-frame windows, and compared to ENERGY STAR® replacement windows.

Because RESFEN is commonly employed as an evaluation tool for energy-efficiency programs, this study expands and refines previous RESFEN calculations to examine low-e storm window performance using multiple house types and assuming a broad range of climate zones to help inform energy-efficiency programs of low-e storm window performance throughout the U.S. The primary output from the RESFEN analysis includes the percentage of whole house energy savings derived from installation of low-e storm windows, along with heating and cooling energy and cost savings. The payback period also can be calculated, but again, the simple payback should be viewed with a cautionary note, as it is not clear that the full effect of reduced air infiltration attributable to storm windows is accounted for in RESFEN.[1]

As part of this study, the RESFEN modeling expands upon previous calculations to cover all U.S. climate zones, add more primary window configurations, use updated U-factor and SHGC values for different storm window and primary window combinations, and update the calculation methodology to be consistent with that used in the ENERGY STAR® program for windows, doors, and skylights. The RESFEN analysis was conducted as outlined below.

- RESFEN calculations were run for the same cities as in the NEAT analysis shown in Figure 2.1, plus two additional cities in climate zones 7 and 8 in Alaska (Anchorage and Fairbanks). This is a total of 22 cities across all eight IECC climate zones.
- RESFEN version 6.0.16 was used, whereas the prior analysis used RESFEN version 5. RESFEN 6 is the version used to help establish criteria for the ENERGY STAR® program for windows, doors, and skylights. Several assumptions for the baseline building were updated as shown in Appendix B, although the general conclusions for relative window comparisons do not change substantially from version 5.

[1] As with the NEAT analysis, it appears that default assumptions built into RESFEN may under estimate the infiltration reductions attributable to the installation of storm windows over primary windows.

- Two homes were modeled: a smaller, older, one-story 1700 ft^2 home, and a larger, newer, two-story 2800 ft^2 home. These two homes also are used in the analysis for the ENERGY STAR® program. The older home has minimal insulation, and the newer home is insulated to the 2006 IECC requirements. Details are shown in Appendix B for the one-story, wood-framed home representative of existing construction and the two-story, wood-framed home representative of new construction.
- Natural-gas heating was used in most cities, except a heat pump was used in climate zones 1 and 2 and certain zone 3 locations where RECS data show that heat pumps are more dominant (DOE-EIA 2009). Central air conditioning cooling was included in all locations.
- The natural-gas and electricity prices used were based on 2012 state average prices taken from the DOE Energy Information Administration Natural Gas Monthly and Electric Power Monthly reports (DOE-EIA 2013).
- The window area was assumed to be 15% of equally distributed floor area, which is the same as the analysis for the ENERGY STAR® program. This is 255 ft^2 for the smaller older one-story home, and 420 ft^2 for the larger newer two-story home, or approximately 17 and 28 windows, respectively.
- Both exterior and interior low-e storm windows and panels were evaluated when installed over three different primary window types (single-pane wood frame, double-pane wood frame, and double-pane metal frame, all with clear glass). Single-pane metal windows were not included, but will be qualified as weatherization measures for cases in which single-pane wood/vinyl windows or double-pane metal windows are used, because the energy savings and cost effectiveness will always be higher. This is because the single-pane, metal-framed window will have the worst U-factor (heat transfer coefficient) of all the primary window types; therefore, the relative improvement in U-factor and energy performance from adding a low-e storm window will be even higher than with the other primary window types.
- Standard low-e glass was modeled in all locations. In addition, solar-control low-e glass also was modeled in southern locations (climate zones 1 through 3, and certain warmer zone 4 locations where cooling degree days exceed heating degree days). The SHGC of the solar control low-e glass was 27% lower than the standard low-e glass. Solar-control low-e storm windows are designed for exterior application, so interior panels with solar-control low-e windows were not modeled. Clear glass storm windows also were modeled for comparison.
- To determine the U-factor and SHGC properties for use in the RESFEN analysis, an independent National Fenestration Rating Council-accredited simulation testing laboratory (Architectural Testing, Inc.) conducted detailed calculations of exterior and interior low-e panels installed over various primary windows using THERM and WINDOW software from LBNL (part of DOE Project DE-EE0004015). The resulting U-factor, SHGC, and Vermont (VT) numbers are shown in Table 3.1 and Table 3.2. This includes many combinations and window types, so the subset in **bold text** within the tables indicates that these window types were used with the RESFEN analysis.
- The most accurate method for modeling windows in RESFEN is to import the detailed solar angle dependent properties from WINDOW, rather than just inputting the simple U-factor and SHGC numbers. However, RESFEN and its underlying DOE2.1E software can only use generic frames rather than the detailed frame mounting modeled by Architectural Testing Inc. Therefore, after consultation with the RESFEN developers at LBNL, the window and solar angle properties were imported by creating windows with generic frames and adjusting the frame properties until the whole window U-factor and SHGC matched the same values shown in Table 3.1 and Table 3.2.

- Air leakage was modeled as 3 cfm/ft^2 for single-pane base windows, 1 cfm/ft^2 for double-pane base windows, 0.3 cfm/ft^2 with exterior storm windows installed, and 0.1 cfm/ft^2 with interior panels installed (Drumheller 2007).[1]
- For simple payback period calculations, the same product cost data was used as in the NEAT analysis. This is a product cost of \$7.85/ ft^2 of window area, plus \$30 per window for installation. To calculate the incremental payback period of low-e glass versus clear glass, a product cost of \$6.85/ ft^2 of window area was used for clear glass storm windows and panels, or 13% lower than the low-e storm window. The installation cost was the same (Cort 2013).

  Overall, approximately 950 simulations were performed.

Table 3.1. Properties for Storm Panels over Wood Base Windows (window types in bold text were used as inputs in RESFEN modeling)

Base Window	Storm Type	U-Factor	SHGC	VT
Wood Double Hung, Single Glazed	**--**	**0.88**	**0.61**	0.66
	Clear, Exterior	0.47	0.54	0.57
	Clear, Interior	0.46	0.54	0.59
	Low-e, Exterior	**0.36**	**0.46**	0.52
	Low-e, Interior	**0.34**	**0.50**	0.54
Wood Double Hung, Double Glazed	**--**	**0.51**	**0.57**	0.61
	Clear, Exterior	0.34	0.49	0.53
	Clear, Interior	0.32	0.51	0.55
	Low-e, Exterior	**0.28**	**0.42**	0.48
	Low-e, Interior	**0.26**	**0.47**	0.50
Wood Fixed, Single Glazed	--	0.87	0.64	0.69
	Clear, Exterior	0.46	0.58	0.62
	Clear, Interior	0.45	0.56	0.62
	Low-e, Exterior	0.34	0.50	0.56
	Low-e, Interior	0.34	0.52	0.57
Wood Fixed, Double Glazed	--	0.47	0.60	0.64
	Clear, Exterior	0.32	0.53	0.57
	Clear, Interior	0.32	0.54	0.58
	Low-e, Exterior	0.27	0.46	0.52
	Low-e, Interior	0.25	0.50	0.53

[1] Specific air-tightness parameter assumptions are based on previous case studies, which measured cfm/s.f. results documented in Drumheller 2007.

Table 3.2. Properties of Storm Panels over Metal Base Windows (window types in bold text were used as inputs in RESFEN modeling)

Base Window	Storm Type	U-Factor	SHGC	VT
Aluminum Double Hung, Single Glazed	--	1.12	0.61	0.65
Worst case mounting	Clear, Exterior	0.67	0.56	0.58
Thermally broken mounting (recommended)	Clear, Exterior	0.58	0.56	0.59
	Clear, Interior	0.53	0.53	0.59
Worst case mounting	Low-e, Exterior	0.57	0.47	0.53
Thermally broken mounting (recommended)	Low-e, Exterior	0.44	0.48	0.54
	Low-e, Interior	0.41	0.50	0.54
Aluminum Double Hung, Double Glazed	**--**	**0.75**	**0.58**	0.60
Worst case mounting	Clear, Exterior	0.55	0.51	0.54
Thermally broken mounting (recommended)	Clear, Exterior	0.45	0.52	0.55
	Clear, Interior	0.41	0.51	0.55
Worst case mounting	Low-e, Exterior	0.49	0.44	0.49
Thermally broken mounting (recommended)	**Low-e, Exterior**	**0.36**	**0.44**	0.50
	Low-e, Interior	**0.32**	**0.47**	0.50
Aluminum Fixed, Single Glazed	--	1.06	0.72	0.77
Worst case mounting	Clear, Exterior	0.62	0.59	0.62
Thermally broken mounting (recommended)	Clear, Exterior	0.55	0.61	0.65
	Clear, Interior	0.51	0.60	0.66
Worst case mounting	Low-e, Exterior	0.51	0.50	0.57
Thermally broken mounting (recommended)	Low-e, Exterior	0.42	0.52	0.59
	Low-e, Interior	0.38	0.56	0.60
Aluminum Fixed, Double Glazed	--	0.62	0.67	0.71
Worst case mounting	Clear, Exterior	0.47	0.54	0.58
Thermally broken mounting (recommended)	Clear, Exterior	0.40	0.56	0.60
	Clear, Interior	0.36	0.57	0.61
Worst case mounting	Low-e, Exterior	0.42	0.47	0.52
Thermally broken mounting (recommended)	Low-e, Exterior	0.33	0.48	0.55
	Low-e, Interior	0.29	0.53	0.56

3.2 RESFEN Results

Table 3.3 through Table 3.6 show the energy savings results for using low-e storm windows installed over different primary window types in different cities/climate zones. Table 3.3 and Table 3.5 show the source energy savings for using low-e storm windows in the smaller, older, one-story home and the larger, newer, two-story home, respectively. Similarly, for the smaller, older, one-story home and the larger, newer, two-story home, Table 3.4 and Table 3.6 show the energy cost savings, simple payback period for the total storm window, and incremental simple payback period for using a low-e storm window versus a clear storm window. The detailed results for each city and home type are included in Appendix C.

Table 3.7 provides a summary of the overall average source energy savings and simple payback periods for each climate zone. The results are averaged over both home types, all cities modeled in each climate zone, and both interior and exterior low-e panels.

Table 3.3. HVAC Source Energy Savings for Low-e Storm Windows and Panels as Calculated by RESFEN – Smaller Older 1-Story Home

		HVAC Source Energy Savings of Low-e Storm Windows Used Over Different Primary Window Types in Smaller, Older, One-Story Home					
		Standard Low-e Glass			Solar-Control, Low-e Glass		
Climate Zone	City, State	Single-Pane, Wood-Framed Window	Double-Pane, Metal-Framed Window	Double-Pane, Wood-Framed Window	Single-Pane, Wood-Framed Window	Double-Pane, Metal-Framed Window	Double-Pane, Wood-Framed Window
8	Fairbanks, AK	18–20%	12–13%	8–10%			
7	Anchorage, AK	23–25%	15–17%	10–12%			
7	Duluth, MN	24–26%	16–17%	10–13%			
6 A	Burlington, VT	25–28%	17–18%	11–14%			
6 A	Minneapolis, MN	25–28%	16–18%	12–13%			
5 A	Boston, MA	28–30%	18–20%	12–15%			
5 A	Rochester, NY	24–26%	16–17%	11–13%			
5 A	Pittsburgh, PA	24–26%	16–17%	11–13%			
5 A	Chicago, IL	25–27%	17–18%	12–13%			
5 B	Denver, CO	24–27%	17–18%	11–13%			
5 B	Boise, ID	25–27%	17–18%	12–13%			
4 A	New York, NY	25–27%	16–18%	11–13%			
4 A	Washington, DC	24–26%	16–17%	11–13%	22%	14%	10%
4 A	Raleigh, NC	19–21%	13–14%	9–10%	19%	12%	8%
4 A	Kansas City, MO	26–28%	17–19%	13–14%	26%	16%	12%
4 C	Seattle, WA	29–32%	20–22%	14–16%			
3 A	Atlanta, GA	24–26%	16–17%	12–13%	25%	17%	13%
3 A	Dallas, TX:						
	Furnace	25%	16%	13%	26%	18%	15%
	Heat pump	21–22%	13–14%	12%	24%	16%	15%
2 A	Jacksonville, FL	18–17%	11%	11–9%	23%	16%	15%
2 A	Houston, TX:						
	Furnace	21%	13%	12–11%	26%	18%	17%
	Heat pump	19–18%	11%	11–10%	24%	16%	16%
2 B	Phoenix, AZ	18–17%	12%	11–10%	23%	17%	16%
1 A	Miami, FL	13–11%	7–6%	10–7%	21%	15%	17%

Notes:
Range of savings indicates exterior and interior low-e panels (first and second numbers, respectively).
Solar-control, low-e panels were modeled for exterior application only.
Installation over metal-framed window assumes thermally broken mounting.
Gray cells not evaluated.

Table 3.4. HVAC Energy Cost Savings of Exterior Low–e Storm Windows over Single–Pane Wood Windows as Calculated by RESFEN – Smaller Older 1–Story Home

		HVAC Energy Cost Savings of Exterior Low–e Storm Windows in Smaller Older 1–Story home					
		Standard Low–e Glass Over Single–Pane Wood Window			Solar Control Low–e Glass Over Single–Pane Wood Window		
Climate Zone	Location	Energy Cost Savings	Simple Payback for Total Product (yrs)	Simple Payback for low–e (yrs)	Energy Cost Savings	Simple Payback for Total Product (yrs)	Simple Payback for low–e (yrs)
8	Fairbanks, AK	$537 (18%)	4.7	2.7			
7	Anchorage, AK	$406 (23%)	6.2	3.4			
7	Duluth, MN	$422 (24%)	6.0	3.6			
6 A	Burlington, VT	$664 (25%)	3.8	2.2			
6 A	Minneapolis, MN	$346 (25%)	7.3	4.2			
5 A	Boston, MA	$470 (28%)	5.3	3.3			
5 A	Rochester, NY	$510 (24%)	4.9	2.7			
5 A	Pittsburgh, PA	$375 (24%)	6.7	3.6			
5 A	Chicago, IL	$299 (25%)	8.4	4.7			
5 B	Denver, CO	$239 (24%)	10.5	5.3			
5 B	Boise, ID	$249 (25%)	10.1	5.3			
4 A	New York, NY	$418 (25%)	6.0	3.5			
4 A	Washington, DC	$352 (24%)	7.1	3.9	$330 (22%)	7.6	5.8
4 A	Raleigh, NC	$267 (20%)	9.3	4.9	$255 (19%)	9.8	6.6
4 A	Kansas City, MO	$368 (27%)	6.8	3.8	$350 (26%)	7.2	5.1
4 C	Seattle, WA	$294 (29%)	8.5	4.7			
3 A	Atlanta, GA	$263 (26%)	9.6	4.9	$255 (26%)	9.9	5.8
3 A	Dallas, TX:						
	Furnace	$212 (25%)	11.8	5.6	$229 (26%)	11.0	4.1
	Heat pump	$174 (21%)	14.4	6.4	$198 (24%)	12.7	4.0
2 A	Jacksonville, FL	$135 (18%)	18.7	7.6	$168 (23%)	15.0	3.8
2 A	Houston, TX:						
	Furnace	$166 (22%)	15.1	6.6	$197 (26%)	12.8	3.7
	Heat pump	$143 (19%)	17.6	7.2	$178 (24%)	14.1	3.6
2 B	Phoenix, AZ	$196 (18%)	12.8	4.5	$247 (23%)	10.2	2.4
1 A	Miami, FL	$117 (13%)	21.4	7.3	$183 (21%)	13.8	2.5

Notes:
Payback will be shorter for leakier primary windows, higher fuel costs, or propane and electrical resistance heating.
Gray cells not evaluated.

Table 3.5. HVAC Source Energy Savings for Low-e Storm Windows and Panels as Calculated by RESFEN – Larger, Newer, Two-Story Home

		HVAC Source Energy Savings of Low-e Storm Windows Used Over Different Primary Window Types in Larger Newer 2-story Home					
		Standard Low-e Glass			Solar Control Low-e Glass		
Climate Zone	City, State	Single-Pane, Wood-Framed Window	Double-Pane, Metal-Framed Window	Double-Pane, Wood-Framed Window	Single-Pane, Wood-Framed Window	Double-Pane, Metal-Framed Window	Double-Pane, Wood-Framed Window
8	Fairbanks, AK	40–43%	28–30%	21–24%			
7	Anchorage, AK	45–48%	32–35%	24–28%			
7	Duluth, MN	46–50%	32–35%	24–28%			
6 A	Burlington, VT	44–48%	31–34%	23–27%			
6 A	Minneapolis, MN	44–47%	30–33%	23–26%			
5 A	Boston, MA	45–49%	31–35%	24–27%			
5 A	Rochester, NY	43–46%	30–32%	23–26%			
5 A	Pittsburgh, PA	43–46%	30–33%	23–26%			
5 A	Chicago, IL	44–47%	30–33%	23–26%			
5 B	Denver, CO	47–50%	34–37%	26–30%			
5 B	Boise, ID	45–48%	33–35%	25–28%			
4 A	New York, NY	43–46%	29–32%	22–25%			
4 A	Washington, DC	40–43%	28–31%	21–24%	39%	27%	20%
4 A	Raleigh, NC	37–39%	25–27%	20–21%	36%	25%	20%
4 A	Kansas City, MO	39–42%	27–29%	21–23%	39%	26%	20%
4 C	Seattle, WA	49–53%	36–39%	28–32%			
3 A	Atlanta, GA	36–38%	25–27%	20–21%	37%	25%	20%
3 A	Dallas, TX:						
	Furnace	34–35%	23–24%	19%	36%	25%	21%
	Heat pump	31%	20–21%	18–17%	35%	25%	22%
2 A	Jacksonville, FL	27–26%	17%	16–14%	33%	24%	23%
2 A	Houston, TX:						
	Furnace	30–29%	19%	17–16%	34%	24%	23%
	Heat pump	27–26%	17%	17–15%	33%	24%	23%
2 B	Phoenix, AZ	25–24%	18%	16–14%	32%	25%	23%
1 A	Miami, FL	17–14%	9–8%	12–9%	27%	19%	22%

Notes:
Range of savings indicates exterior and interior low-e panels (first and second numbers, respectively).
Solar control low-e panels were modeled for exterior application only.
Installation over metal-framed window assumes thermally broken mounting.
Gray cells not evaluated.

Table 3.6. HVAC Energy Cost Savings of Exterior Low-e Storm Windows over Single-Pane Wood Windows as Calculated by RESFEN – Larger, Newer, Two-Story Home

		HVAC Energy Cost Savings of Exterior Low-e Storm Windows in Larger, Newer, Two-Story Home					
		Standard Low-e Glass Over Single-Pane Wood Window			Solar Control Low-e Glass Over Single-Pane Wood Window		
Climate Zone	Location	Energy Cost Savings	Simple Payback for Total Product (yrs)	Simple Payback for low-e (yrs)	Energy Cost Savings	Simple Payback for Total Product (yrs)	Simple Payback for low-e (yrs)
8	Fairbanks, AK	$824 (40%)	5.0	2.8			
7	Anchorage, AK	$619 (45%)	6.7	3.7			
7	Duluth, MN	$645 (46%)	6.4	3.9			
6 A	Burlington, VT	$986 (45%)	4.2	2.4			
6 A	Minneapolis, MN	$516 (43%)	8.0	4.7			
5 A	Boston, MA	$688 (45%)	6.0	3.6			
5 A	Rochester, NY	$749 (42%)	5.5	3.1			
5 A	Pittsburgh, PA	$547 (43%)	7.6	4.1			
5 A	Chicago, IL	$442 (43%)	9.4	5.3			
5 B	Denver, CO	$340 (45%)	12.2	6.2			
5 B	Boise, ID	$363 (45%)	11.4	6.0			
4 A	New York, NY	$615 (42%)	6.7	3.9			
4 A	Washington, DC	$508 (41%)	8.2	4.5	$488 (39%)	8.5	5.7
4 A	Raleigh, NC	$369 (38%)	11.2	5.9	$362 (37%)	11.4	6.6
4 A	Kansas City, MO	$529 (41%)	7.8	4.3	$512 (39%)	8.1	5.3
4 C	Seattle, WA	$425 (50%)	9.7	.2			
3 A	Atlanta, GA	$410 (39%)	10.1	5.4	$394 (38%)	10.5	6.7
3 A	Dallas, TX:						
	Furnace	$317 (34%)	13.0	6.5	$334 (36%)	12.4	5.1
	Heat pump	$260 (31%)	15.9	7.3	$292 (35%)	14.2	4.7
2 A	Jacksonville, FL	$190 (27%)	21.8	9.3	$234 (33%)	17.8	4.8
2 A	Houston, TX:						
	Furnace	$240 (30%)	17.3	8.0	$278 (35%)	14.9	4.7
	Heat pump	$208 (27%)	19.9	8.7	$254 (33%)	16.3	4.5
2 B	Phoenix, AZ	$254 (26%)	16.3	6.1	$319 (32%)	13.0	3.1
1 A	Miami, FL	$149 (17%)	27.7	9.9	$234 (27%)	17.7	3.3

Notes:
Payback will be shorter for leakier primary windows, higher fuel costs, or propane and electrical resistance heating.
Gray cells not evaluated.

Table 3.7. Overall Average Savings and Payback Period by Climate Zone. Results in climate zones 1–3 are for solar control low–e.

	Source Energy Savings			Simple Payback for Total Product (years)			Incremental Simple Payback for Low-e (years)		
	Over Wood Frame, Single Pane			Over Wood Frame, Single Pane			Over Wood Frame, Single Pane		
Zone	**Average**	Min	Max	**Average**	Min	Max	**Average**	Min	Max
8	**30%**	18%	43%	**4.7**	4.3	5.0	**2.5**	2.1	2.8
7	**36%**	23%	50%	**6.1**	5.5	6.7	**3.3**	2.7	3.9
6	**36%**	25%	48%	**5.6**	3.5	8.0	**3.1**	1.8	4.7
5	**36%**	24%	50%	**7.9**	4.6	12.2	**4.1**	2.4	6.2
4	**34%**	19%	53%	**7.9**	5.6	11.2	**4.1**	2.9	5.9
3	**31%**	24%	38%	**10.9**	9.0	14.2	**5.0**	4.0	6.7
2	**28%**	23%	34%	**14.3**	10.2	17.8	**3.8**	2.4	4.8
1	**24%**	21%	27%	**15.7**	13.8	17.7	**2.9**	2.5	3.3

	Source Energy Savings			Simple Payback for Total Product (years)			Incremental Simple Payback for Low-e (years)		
	Over Metal Frame, Double Pane			Over Metal Frame, Double Pane			Over Metal Frame, Double Pane		
Zone	**Average**	Min	Max	**Average**	Min	Max	**Average**	Min	Max
8	**21%**	12%	30%	**7.7**	7.0	8.4	**2.6**	2.4	2.7
7	**25%**	15%	35%	**10.1**	9.1	11.1	**3.3**	3.0	3.6
6	**25%**	16%	34%	**9.5**	5.7	13.9	**3.1**	2.0	4.5
5	**25%**	16%	37%	**12.9**	7.6	19.4	**4.0**	2.5	5.8
4	**24%**	13%	39%	**12.9**	9.3	18.4	**4.0**	3.1	5.6
3	**21%**	16%	27%	**17.7**	14.4	22.8	**4.7**	3.8	6.0
2	**20%**	16%	25%	**22.1**	14.8	28.3	**3.7**	2.3	4.7
1	**17%**	15%	19%	**23.8**	20.4	27.1	**2.9**	2.5	3.3

	Source Energy Savings			Simple Payback for Total Product (years)			Incremental Simple Payback for Low-e (years)		
	Over Wood Frame, Double Pane			Over Wood Frame, Double Pane			Over Wood Frame, Double Pane		
Zone	**Average**	Min	Max	**Average**	Min	Max	**Average**	Min	Max
8	**16%**	8%	24%	**11.4**	10.1	12.6	**3.3**	2.9	3.5
7	**19%**	10%	28%	**15.5**	13.5	17.4	**4.3**	3.6	4.9
6	**19%**	11%	27%	**14.2**	8.5	20.9	**4.0**	2.3	5.7
5	**19%**	11%	30%	**19.5**	11.1	30.1	**5.1**	3.0	7.4
4	**18%**	9%	32%	**19.4**	13.6	27.4	**5.0**	3.7	6.8
3	**17%**	12%	22%	**24.5**	20.9	28.1	**5.8**	4.4	8.3
2	**20%**	15%	23%	**23.8**	15.7	29.8	**4.1**	2.5	5.1
1	**20%**	17%	22%	**20.4**	17.8	23.1	**3.0**	2.6	3.4

The definition of cost effectiveness will vary depending upon the consumer or program viewpoint, but one possible criterion is to use a return-on-investment of greater than 7 to 10%, which corresponds to a simple payback periods of 10 to 14 year or less. As shown in Table 3.4, Table 3.6, and Table 3.7, two types of simple payback period were calculated from the results to evaluate cost effectiveness. First, a simple payback period for the total storm window cost was calculated, including installation cost. Second, the incremental payback period for using low-e glass instead of clear glass was calculated. This is useful when the homeowner has chosen to install a storm window or panel for other reasons (e.g., increased comfort, noise reduction, window protection, reduced air leakage, etc.) regardless of the total product payback period, and it is the incremental payback period that is important in determining whether the homeowner uses low-e glass or clear glass. Nonetheless, the simple payback periods reported in Table 3.4, Table 3.6, and Table 3.7 for low-e storm windows are considerably shorter than payback periods for replacement windows, which are commonly over 25 years when including removal and installation costs.

Note that the energy use and costs calculated by RESFEN are for the whole home heating and cooling energy use, but do not include the energy use for hot water, appliances, lighting, and plug loads. Therefore, energy cost savings percentages should be applied directly to just the heating and cooling component a homeowner's utility bill, not to the overall bill.

The following general points and trends were observed:

- Low-e storm windows show significant percent energy savings across all climate zones. The total magnitude of the energy cost and savings is obviously more in the north where total home energy use is higher than in the south, and the payback period is commensurately shorter in the north than in the south.
- Regular low-e glass provides higher energy savings in climate zones 4 through 8, and solar control low-e provides higher energy savings in climate zones 1 through 3.
- The energy savings is highest for use of low-e storm windows installed over single-pane windows, followed by the metal-frame, double-pane windows, and the wood-frame, double-pane windows. Essentially, the lower performing the primary windows, the higher relative improvement from using low-e storm windows.
- Interior low-e panels showed slightly higher energy savings than exterior low-e storm windows, due to the somewhat lower U-factor and air leakage from using interior panels.
- The percent energy savings from using low-e storm windows is actually higher in the larger, newer, two-story home than in the smaller, older, one-story home, even though both homes have the same relative window area (15% of the conditioned floor area). This is because in the better-insulated, newer home, the primary windows become the weak link in the envelope and contribute relatively more to the overall energy use. As a result, improving the performance of the primary windows by adding a low-e storm window has a larger relative impact. Of course, it also is less likely to find single glazing in newer homes, although a significant amount of newer homes can have windows with double pane clear glass.
- The RESFEN energy savings are somewhat higher than the NEAT energy savings (e.g. 22 to 32% site energy savings for the RESFEN smaller, older, one-story home versus 16 to 22% for the NEAT WFVC6 home) due to differences in the model homes, but the relative trends are similar, and

the payback periods are similar (e.g. 3.8 to 11 years for the RESFEN smaller, older, one-story home versus 3.8 to 9.9 years for the NEAT WFVC6 home).

- While there is no specific cutoff criterion for cost effectiveness such as SIR >1 in the NEAT analysis for weatherization programs, the RESFEN results for payback period show the same general trends as the NEAT SIR results. Low-e storm windows are cost effective when installed over single-pane windows in climate zones 3 through 8, and over double-pane, metal-framed windows in climate zones 4 through 8. Solar-control, low-e glass is more cost effective in climate zone 3, whereas regular low-e is more cost effective in zones 4 through 8.
- Low-e storm windows also are cost effective when installed over double-pane wood or vinyl-framed windows in climate zones 6 through 8, as well as certain parts of zones 4 through 5 depending on the home type and local fuel cost.
- In climate zones 1 and 2, storm windows with solar-control, low-e glass can be cost effective, but should be evaluated on a case-by-case basis.
- The incremental cost for using low-e glass versus clear glass is always cost effective with short payback periods in *all* climate zones and over *all* window types. In other words, when a homeowner has already decided to install a storm window or interior panel, regardless of location, it should always be a low-e storm window or panel.
- The analysis was performed with either a natural-gas furnace or electrical heat pump depending on location. For homes using propane or electrical-resistance heating, the energy cost savings and cost effectiveness of low-e storm windows will be even higher, because the effective heating fuel cost and savings from using low-e storm windows will be higher.

Additionally, the effect of how exterior storm windows are mounted over metal-framed windows was examined. The detailed simulations used to determine the U-factor and SHGC values shown in Table 3.2 also examined different attachment methods. Both exterior storm windows mounted over wood frame windows and interior panels will be mounted to a nonmetal surface, therefore ensuring no thermal bridging effects. However, with exterior storm windows mounted over metal framed windows, the storm window can either be mounted to surrounding wood brick mold or a wood blind stop with no metal-to-metal contact, or it can be mounted directly to the metal window frame. The first “thermally broken” mounting method is the recommended practice. The latter method is still beneficial for improving the thermal performance and air leakage of the existing window, but some performance is sacrificed from the direct metal-to-metal thermal bridge.

To examine the magnitude of this effect, both mounting methods were included in the RESFEN analysis. Example results for Boston are shown in Table 3.8. While the exterior low-e storm window provides significant energy savings over metal-framed windows in both cases, mounting the storm window with direct metal-to-metal contact decreases the potential energy savings by about one-third and increases the payback period by 5 years. Therefore, it is recommended to provide thermally broken mounting with no metal-to-metal contact wherever possible.

Table 3.8. Effect of Different Mounting Methods for Installing Exterior Storm Windows over Metal-Framed, Double-Pane Windows in Boston, Massachusetts

	Smaller, Older, One-Story Home		Larger, Newer, Two-Story Home	
	Thermally Broken Mounting (no metal-to-metal contact)	Direct Metal-to-Metal Attachment	Thermally Broken Mounting (no metal-to-metal contact)	Direct Metal-to-Metal Attachment
Energy Cost Savings	$277 (18.0%)	$178 (11.6%)	$395 (31.4%)	$262 (20.8%)
Simple Payback for Total Product (years)	9.1	14.1	10.5	15.8
Incremental Simple Payback for Low-e (years)	2.9	4.7	3.3	5.1

4.0 Conclusions and Recommendations Based on the NEAT and RESFEN Results

Most weatherization assistance programs will only fund energy-efficient weatherization measures if they meet certain cost-effectiveness criteria, typically defined in terms of the savings-to-investment ratio (SIR), where installation of the energy-efficiency measure must yield an SIR greater than 1 to qualify for weatherization funding. Weatherization programs typically use the NEAT model to calculate SIR for weatherization measures. The RESFEN model was specifically designed to compare the annual energy performance of different fenestration options in single-family homes, and it is used as the basis of the ENERGY STAR® program for windows, doors, and skylights. This report provides calculations from both the NEAT and RESFEN modeling platforms to address the different audiences that will use the data (utilities, weatherization programs, federal energy-efficiency programs, consumers, etc.).

The definition of cost effectiveness will vary depending upon the consumer or program viewpoint. For the purposes of this report, the criteria used to determine and discuss cost-effective measures include the SIR measurement (i.e., SIR greater than 1) as well as simple payback periods, where a 10 to 14-year payback (or less) would be considered cost-effective. Using the SIR and these payback periods as the basis for measuring low-e storm window cost effectiveness, the results from both the NEAT and RESFEN analyses are generally consistent, and yield the following conclusions:

- Low-e storm windows are qualified as cost-effective weatherization measures (based on SIR greater than 1) and are recommended for installation over all single-pane windows and double-pane, metal-framed windows in climate zones 3 through 8. The use of solar-control low-e storm windows is recommended in climate zone 3, and may also be considered in warmer parts of zone 4 where cooling degree days exceed heating degree days. The use of regular low-e storm windows is recommended in zones 4 through 8, although solar-control low-e windows can sometimes be beneficial in specific applications even in northern zones (e.g., large west-facing windows in areas with hot summers).
- Low-e storm windows are also qualified as weatherization measures and recommended for installation over double-pane wood/vinyl-framed windows in climate zones 6 through 8, and in eastern parts of zone 5 where higher heating fuel costs exist. They will also be qualified as weatherization measures in more zones when propane or electrical-resistance heating are used, and where the primary window is particularly leaky (e.g. “loose” or “very loose” by NEAT definitions).
- The incremental cost for using low-e glass versus clear glass is always cost effective in all climate zones and over all window types. Therefore, when a homeowner has chosen to install a storm window or interior panel for reasons other than just energy savings (e.g., increased comfort, noise reduction, window protection, reduced air leakage, etc.), it should be a low-e storm window or panel regardless of location.
- Where exterior low-e storm windows are installed over metal-framed primary windows, the storm window should be mounted with no metal-to-metal contact where possible (i.e., a “thermally broken” installation).

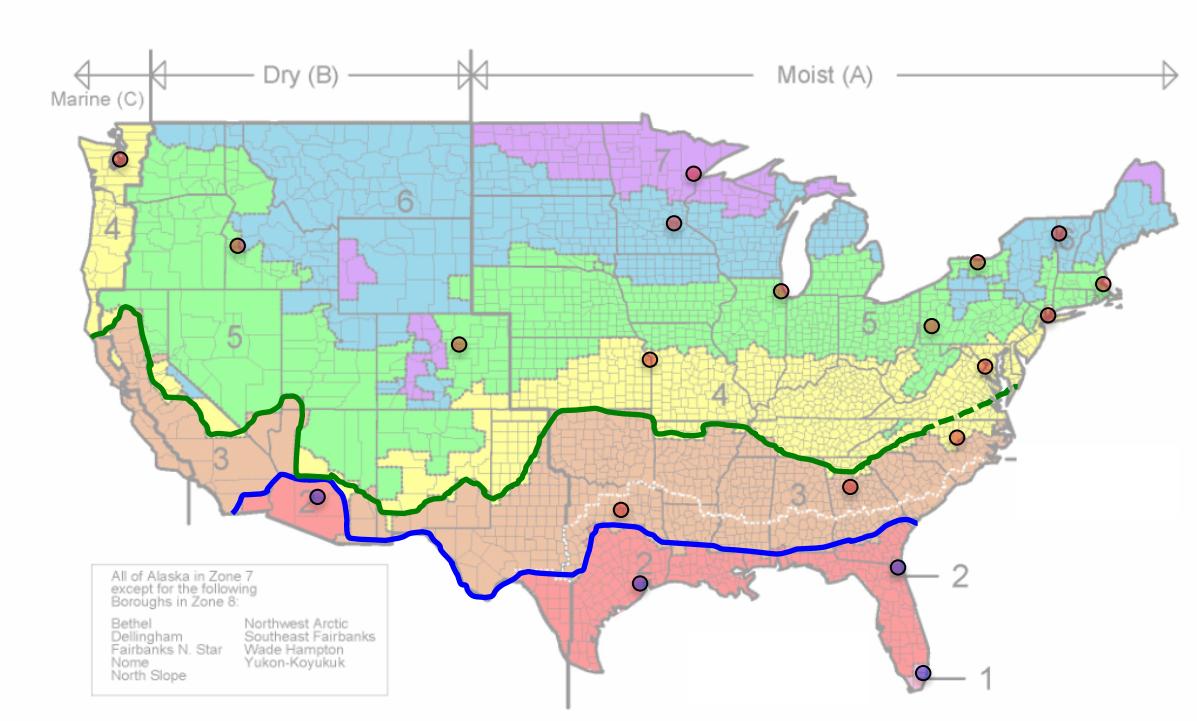

Figure 4.1 is a map with the overall general recommended regions for the use of low-e storm windows installed over single-pane windows and double-pane, metal-framed windows.

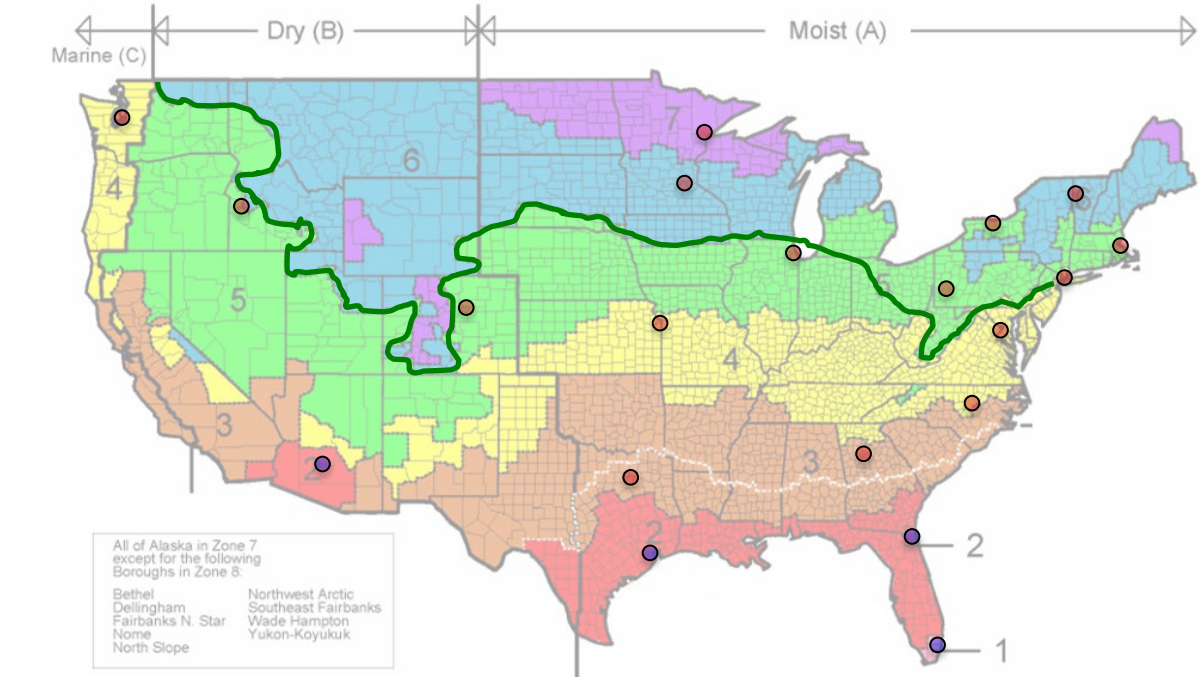

Figure 4.2 is a map with the overall general recommended regions for the use of low-e storm windows installed over double-pane, wood/vinyl-framed windows.

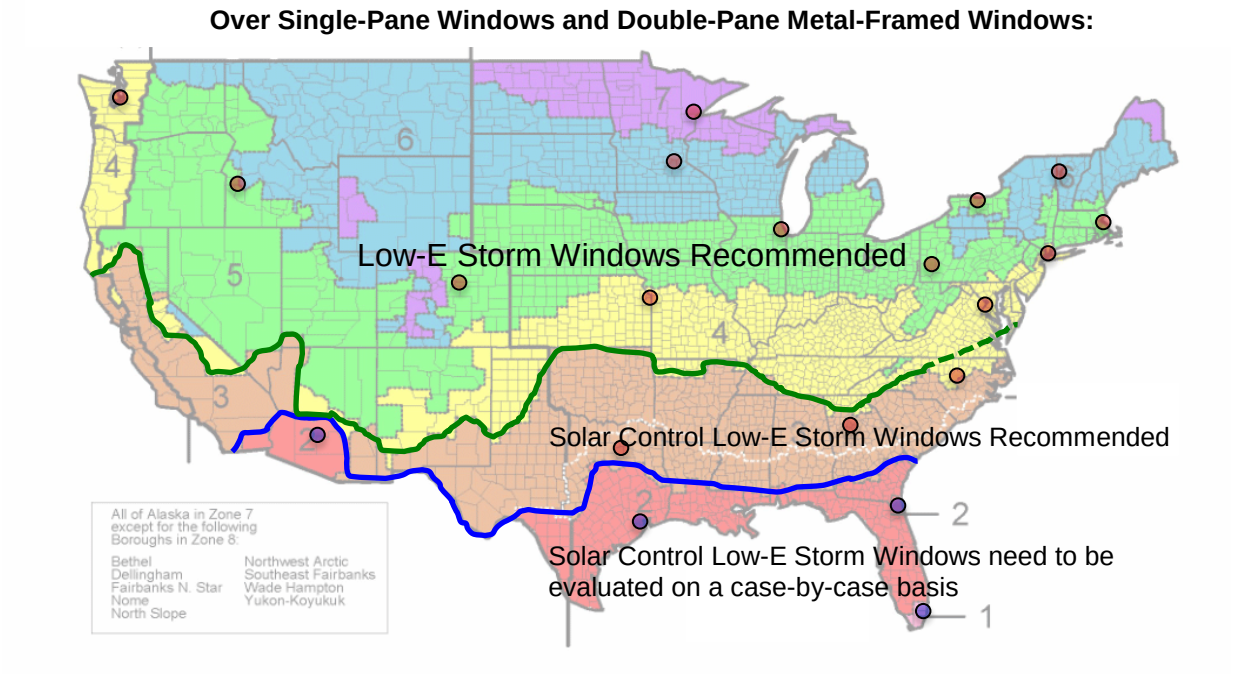

Figure 4.1. Overall Recommended Regions for the Use of Low-e Storm Windows Installed Over Single-Pane Windows and Double-Pane Metal-Framed Windows and the Location of Cities Included in this Analysis.

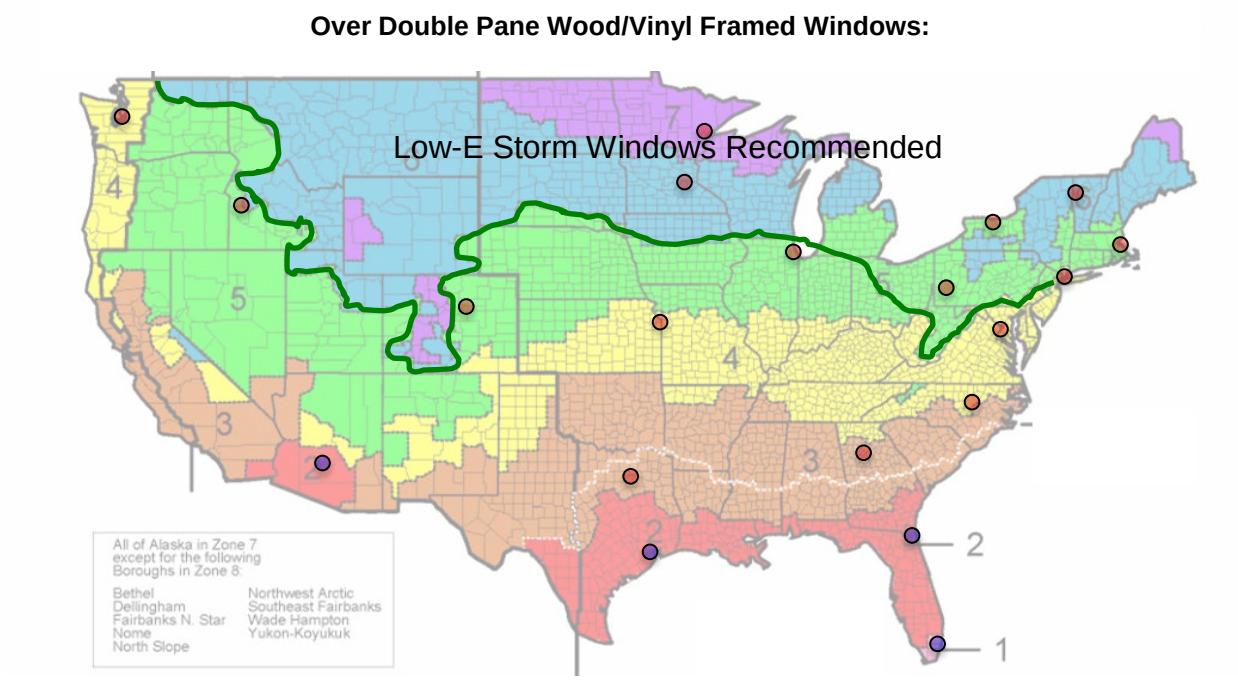

Figure 4.2. Overall Recommended Regions for Use of Low-e Storm Windows Installed Over Double-Pane, Wood/Vinyl-Framed Windows. The region where low-e storm windows are recommended will be larger than shown for homes using propane or electrical resistance heating, or those that have particularly leaky windows. Points indicated on the map show the location of cities included in this analysis.

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Appendix A

NEAT Calculation Results for Each City

Duluth MN
Zone 7

HDD65	9818
CDD50	1536
Natural Gas ($/Mcf, 2012 avg)	$7.97
Electricity ($/kWh, 2012 avg)	$0.1137
Low-e Storms $7.85/ft2 + $30/window	

SIR with different primary window types:

	Home type	Single pane wood/vinyl	Double pane metal	Double pane wood/vinyl
1	Exposed Floor 1	2.1	2.0	1.3
2	Wood Frame Cape Cod 1 KW 1	2.1	2.0	1.4
3	Wood Frame Cape Cod 2 KW 2	2.1	2.0	1.3
4	Wood Frame Cape Cod 3 KW 3	2.1	2.0	1.3
5	Wood Frame Cape Cod 4 KW 4	2.1	2.0	1.4
6	Wood Frame Cape Cod 1 KW 5	2.1	2.0	1.3
7	Masonry 1	2.1	2.0	1.3
8	Masonry 2	2.1	2.0	1.3
9	Masonry 3	2.1	2.0	1.3
10	Masonry 4	2.1	2.1	1.3
11	Masonry 5	2.1	2.1	1.3
12	Masonry 6	2.1	2.1	1.3
13	Row House Masonry 1	2.1	2.0	1.3
14	Row House Masonry 2	2.1	2.0	1.3
15	Row House Wood Frame 1	2.1	2.0	1.5
16	Row House Wood Frame 2	2.1	2.0	1.3
17	Semi Detached Masonry 1	2.1	2.0	1.3
18	Semi Detached Masonry 2	2.1	2.2	1.3
19	Semi Detached Wood Frame 1	2.1	2.0	1.4
20	Semi Detached Wood Frame 2	2.1	2.0	1.3
21	Wood Frm Cond Bsmt 1	2.1	2.0	1.3
22	Wood Frm Cond Bsmt 2	2.1	2.0	1.3
23	Wood Frm Cond Bsmt 3	2.1	2.0	1.3
24	Wood Frm Cond Bsmt 4	2.1	2.1	1.3
25	Wood Frm Slab 1	2.1	2.1	1.3
26	Wood Frm Slab 2	2.2	2.1	1.3
27	Wood Frm Slab 3	2.2	2.1	1.3
28	Wood Frm Slab 4	2.2	2.1	1.3
29	Wood Frm Uncon Bsmt 1	2.1	2.0	1.3
30	Wood Frm Uncon Bsmt 2	2.1	2.0	1.3
31	Wood Frm Uncon Bsmt 3	2.1	2.0	1.3
32	Wood Frm Uncon Bsmt 4	2.1	2.0	1.3
33	Wood Frm Uncon Bsmt 5	2.1	2.0	1.3
34	Wood Frm Vented Crawl Space 1	2.1	2.0	1.3
35	Wood Frm Vented Crawl Space 2	2.1	2.0	1.3
36	Wood Frm Vented Crawl Space 3	2.1	2.0	1.3
37	Wood Frm Vented Crawl Space 4	2.1	2.0	1.3
38	Wood Frm Vented Crawl Space 5	2.1	2.0	1.3
39	Wood Frm Vented Crawl Space 6	2.1	2.0	1.3
	Average SIR	**2.1**	**2.0**	**1.3**
	Max SIR	2.2	2.2	1.5
	Min SIR	2.1	2	1.3

Other metrics: Wood Frame Vented Crawl Space home Single pane wood windows		if include 1/3 of air inf savings
Annual cost savings	$189	$244
Measure Cost	$1,386	
Simple Payback	**7.3**	5.7
Energy Savings (Mbtu/yr)		
Initial home heat+cool	124.6	
Storm savings	23.8	
% reduction	**19%**	

Burlington VT
Zone 6

HDD65	7771		
CDD50	2228		
Natural Gas ($/Mcf, 2012 avg)	$16.73	$1.635	per therm
Electricity ($/kWh, 2012 avg)	$0.1731		
Low-e Storms $7.85/ft2 + $30/window			

SIR with different primary window types:

	Home type	Single pane wood/vinyl	Double pane metal	Double pane wood/vinyl
1	Exposed Floor 1	3.2	3.0	1.8
2	Wood Frame Cape Cod 1 KW 1	3.1	3.0	1.9
3	Wood Frame Cape Cod 2 KW 2	3.1	3.0	1.8
4	Wood Frame Cape Cod 3 KW 3	3.2	3.0	1.8
5	Wood Frame Cape Cod 4 KW 4	3.2	3.0	1.8
6	Wood Frame Cape Cod 1 KW 5	3.2	3.1	1.9
7	Masonry 1	3.3	3.1	1.9
8	Masonry 2	3.2	3.1	1.8
9	Masonry 3	3.2	3.1	1.8
10	Masonry 4	3.3	3.2	1.9
11	Masonry 5	3.3	3.2	1.9
12	Masonry 6	3.3	3.1	1.9
13	Row House Masonry 1	3.1	3.0	2.0
14	Row House Masonry 2	3.2	3.1	2.2
15	Row House Wood Frame 1	3.1	3.0	2.1
16	Row House Wood Frame 2	3.2	3.0	2.2
17	Semi Detached Masonry 1	3.2	3.1	1.9
18	Semi Detached Masonry 2	3.2	3.1	1.9
19	Semi Detached Wood Frame 1	3.1	3.0	1.8
20	Semi Detached Wood Frame 2	3.2	3.1	1.8
21	Wood Frm Cond Bsmt 1	3.3	3.1	1.8
22	Wood Frm Cond Bsmt 2	3.2	3.1	1.8
23	Wood Frm Cond Bsmt 3	3.2	3.0	1.7
24	Wood Frm Cond Bsmt 4	3.3	3.1	1.9
25	Wood Frm Slab 1	3.3	3.1	1.9
26	Wood Frm Slab 2	3.3	3.1	1.9
27	Wood Frm Slab 3	3.3	3.2	1.9
28	Wood Frm Slab 4	3.3	3.1	1.9
29	Wood Frm Uncon Bsmt 1	3.2	3.0	1.8
30	Wood Frm Uncon Bsmt 2	3.2	3.0	1.8
31	Wood Frm Uncon Bsmt 3	3.2	3.1	1.8
32	Wood Frm Uncon Bsmt 4	3.0	2.9	1.7
33	Wood Frm Uncon Bsmt 5	3.2	3.1	1.9
34	Wood Frm Vented Crawl Space 1	3.2	3.0	1.8
35	Wood Frm Vented Crawl Space 2	3.2	3.1	1.8
36	Wood Frm Vented Crawl Space 3	3.2	3.1	1.8
37	Wood Frm Vented Crawl Space 4	3.2	3.1	1.8
38	Wood Frm Vented Crawl Space 5	3.2	3.1	1.8
39	Wood Frm Vented Crawl Space 6	3.2	3.1	1.8
	Average SIR	**3.2**	**3.1**	**1.9**
	Max SIR	3.3	3.2	2.2
	Min SIR	3.0	2.9	1.7

Other metrics:		
Wood Frame Vented Crawl Space home		
Single pane wood windows		
		if include 1/3 of air inf savings
Annual cost savings	$287	$368
Measure Cost	$1,386	
Simple Payback	**4.8**	3.8
Energy Savings (Mbtu/yr)		
Initial home heat+cool	91.1	
Storm savings	17.1	
% reduction	**19%**	

Minneapolis MN
Zone 6

HDD65	7981		
CDD50	2680		
Natural Gas ($/Mcf, 2012 avg)	$7.97	$0.779	per therm
Electricity ($/kWh, 2012 avg)	$0.1137		
Low-e Storms $7.85/ft2 + $30/window			

SIR with different primary window types:

	Home type	**Single pane wood/vinyl**	**Double pane metal**	**Double pane wood/vinyl**
1	Exposed Floor 1	1.6	1.6	1.2
2	Wood Frame Cape Cod 1 KW 1	1.6	1.7	1.5
3	Wood Frame Cape Cod 2 KW 2	1.7	1.6	1.5
4	Wood Frame Cape Cod 3 KW 3	1.6	1.6	1.1
5	Wood Frame Cape Cod 4 KW 4	1.7	1.6	1.1
6	Wood Frame Cape Cod 1 KW 5	1.7	1.7	1.5
7	Masonry 1	1.7	1.6	1.3
8	Masonry 2	1.6	1.6	1.3
9	Masonry 3	1.7	1.6	1.1
10	Masonry 4	1.7	1.6	1.3
11	Masonry 5	1.6	1.6	1.1
12	Masonry 6	1.7	1.6	1.3
13	Row House Masonry 1	1.4	1.3	--
14	Row House Masonry 2	1.4	1.3	--
15	Row House Wood Frame 1	1.4	1.3	--
16	Row House Wood Frame 2	1.4	1.3	--
17	Semi Detached Masonry 1	1.7	1.6	1.3
18	Semi Detached Masonry 2	1.7	1.6	1.3
19	Semi Detached Wood Frame 1	1.6	1.6	1.2
20	Semi Detached Wood Frame 2	1.7	1.6	1.2
21	Wood Frm Cond Bsmt 1	1.6	1.6	1.1
22	Wood Frm Cond Bsmt 2	1.7	1.6	1.3
23	Wood Frm Cond Bsmt 3	1.7	1.6	1.2
24	Wood Frm Cond Bsmt 4	1.7	1.6	1.1
25	Wood Frm Slab 1	1.7	1.6	1.3
26	Wood Frm Slab 2	1.7	1.6	1.3
27	Wood Frm Slab 3	1.7	1.6	1.3
28	Wood Frm Slab 4	1.7	1.6	1.1
29	Wood Frm Uncon Bsmt 1	1.6	1.5	1.1
30	Wood Frm Uncon Bsmt 2	1.7	1.6	1.2
31	Wood Frm Uncon Bsmt 3	1.6	1.5	1.2
32	Wood Frm Uncon Bsmt 4	1.6	1.5	1.2
33	Wood Frm Uncon Bsmt 5	1.7	1.6	1.2
34	Wood Frm Vented Crawl Space 1	1.6	1.5	1.1
35	Wood Frm Vented Crawl Space 2	1.7	1.6	1.2
36	Wood Frm Vented Crawl Space 3	1.6	1.5	1.2
37	Wood Frm Vented Crawl Space 4	1.6	1.6	1.1
38	Wood Frm Vented Crawl Space 5	1.7	1.6	1.2
39	Wood Frm Vented Crawl Space 6	1.7	1.6	1.1
	Average SIR	**1.6**	**1.6**	**1.2**
	Max SIR	1.7	1.7	1.5
	Min SIR	1.4	1.3	1.1

Other metrics:		if include 1/3 of air inf savings
Wood Frame Vented Crawl Space home		
Single pane wood windows		
Annual cost savings	$147	$190
Measure Cost	$1,386	
Simple Payback	**9.4**	7.3
Energy Savings (Mbtu/yr)		
Initial home heat+cool	98.1	
Storm savings	18.3	
% reduction	**19%**	

Boston MA
Zone 5

HDD65	5641	
CDD50	2897	
Natural Gas ($/Mcf, 2011 avg)	$13.81	(2012 average not available)
Electricity ($/kWh, 2012 avg)	$0.1494	
Low-e Storms $7.85/ft2 + $30/window		

SIR with different primary window types:

	Home type	Single pane wood/vinyl	Double pane metal	Double pane wood/vinyl
1	Exposed Floor 1	2.2	2.2	1.5
2	Wood Frame Cape Cod 1 KW 1	2.2	2.1	1.5
3	Wood Frame Cape Cod 2 KW 2	2.2	2.1	1.5
4	Wood Frame Cape Cod 3 KW 3	2.2	2.1	1.5
5	Wood Frame Cape Cod 4 KW 4	2.2	2.1	1.4
6	Wood Frame Cape Cod 1 KW 5	2.3	2.2	1.5
7	Masonry 1	2.3	2.2	1.6
8	Masonry 2	2.3	2.2	1.5
9	Masonry 3	2.4	2.3	1.5
10	Masonry 4	2.3	2.2	1.6
11	Masonry 5	2.3	2.3	1.6
12	Masonry 6	2.3	2.3	1.5
13	Row House Masonry 1	2.0	1.9	1.2
14	Row House Masonry 2	2.0	1.9	1.2
15	Row House Wood Frame 1	2.0	1.9	1.1
16	Row House Wood Frame 2	2.3	2.0	1.2
17	Semi Detached Masonry 1	2.3	2.2	1.6
18	Semi Detached Masonry 2	2.4	2.3	1.5
19	Semi Detached Wood Frame 1	2.2	2.1	1.4
20	Semi Detached Wood Frame 2	2.3	2.2	1.5
21	Wood Frm Cond Bsmt 1	2.3	2.2	1.5
22	Wood Frm Cond Bsmt 2	2.3	2.2	1.5
23	Wood Frm Cond Bsmt 3	2.3	2.2	1.5
24	Wood Frm Cond Bsmt 4	2.3	2.2	1.5
25	Wood Frm Slab 1	2.3	2.3	1.5
26	Wood Frm Slab 2	2.4	2.3	1.5
27	Wood Frm Slab 3	2.4	2.3	1.5
28	Wood Frm Slab 4	2.4	2.3	1.5
29	Wood Frm Uncon Bsmt 1	2.2	2.2	1.5
30	Wood Frm Uncon Bsmt 2	2.3	2.2	1.4
31	Wood Frm Uncon Bsmt 3	2.3	2.2	1.4
32	Wood Frm Uncon Bsmt 4	2.3	2.2	1.5
33	Wood Frm Uncon Bsmt 5	2.3	2.2	1.5
34	Wood Frm Vented Crawl Space 1	2.2	2.2	1.5
35	Wood Frm Vented Crawl Space 2	2.3	2.2	1.5
36	Wood Frm Vented Crawl Space 3	2.3	2.2	1.5
37	Wood Frm Vented Crawl Space 4	2.3	2.2	1.4
38	Wood Frm Vented Crawl Space 5	2.3	2.2	1.4
39	Wood Frm Vented Crawl Space 6	2.3	2.2	1.5
	Average SIR	**2.3**	**2.2**	**1.5**
	Max SIR	2.4	2.3	1.6
	Min SIR	2.0	1.9	1.1

Other metrics: Wood Frame Vented Crawl Space home Single pane wood windows		if include 1/3 of air inf savings
Annual cost savings	$204	$265
Measure Cost	$1,386	
Simple Payback	**6.8**	5.2
Energy Savings (Mbtu/yr)		
Initial home heat+cool	68.4	
Storm savings	14.7	
% reduction	**21%**	

Rochester NY
Zone 5

HDD65	6734	
CDD50	2406	
Natural Gas ($/Mcf, 2011 avg)	$13.71	(2012 average not available)
Electricity ($/kWh, 2012 avg)	$0.1769	
Low-e Storms $7.85/ft2 + $30/window		

SIR with different primary window types:

	Home type	Single pane wood/vinyl	Double pane metal	Double pane wood/vinyl
1	Exposed Floor 1	2.7	2.6	1.8
2	Wood Frame Cape Cod 1 KW 1	2.7	2.6	1.8
3	Wood Frame Cape Cod 2 KW 2	2.7	2.6	1.9
4	Wood Frame Cape Cod 3 KW 3	2.7	2.6	1.8
5	Wood Frame Cape Cod 4 KW 4	2.7	2.6	1.9
6	Wood Frame Cape Cod 1 KW 5	2.8	2.7	1.9
7	Masonry 1	2.8	2.7	1.9
8	Masonry 2	2.8	2.7	1.7
9	Masonry 3	2.7	2.6	1.8
10	Masonry 4	2.7	2.6	1.9
11	Masonry 5	2.7	2.6	1.9
12	Masonry 6	2.7	2.6	1.8
13	Row House Masonry 1	2.8	2.3	1.3
14	Row House Masonry 2	2.8	2.3	1.4
15	Row House Wood Frame 1	2.7	2.3	1.4
16	Row House Wood Frame 2	2.8	2.4	1.5
17	Semi Detached Masonry 1	2.8	2.7	1.9
18	Semi Detached Masonry 2	2.8	2.7	1.8
19	Semi Detached Wood Frame 1	2.7	2.6	1.7
20	Semi Detached Wood Frame 2	2.8	2.7	1.8
21	Wood Frm Cond Bsmt 1	2.8	2.7	1.9
22	Wood Frm Cond Bsmt 2	2.8	2.7	1.8
23	Wood Frm Cond Bsmt 3	2.8	2.7	1.7
24	Wood Frm Cond Bsmt 4	2.8	2.7	1.8
25	Wood Frm Slab 1	2.8	2.7	1.9
26	Wood Frm Slab 2	2.8	2.7	1.8
27	Wood Frm Slab 3	2.8	2.7	1.8
28	Wood Frm Slab 4	2.8	2.7	1.8
29	Wood Frm Uncon Bsmt 1	2.7	2.6	1.8
30	Wood Frm Uncon Bsmt 2	2.7	2.6	1.7
31	Wood Frm Uncon Bsmt 3	2.8	2.7	1.7
32	Wood Frm Uncon Bsmt 4	2.6	2.5	1.8
33	Wood Frm Uncon Bsmt 5	2.8	2.7	1.8
34	Wood Frm Vented Crawl Space 1	2.7	2.6	1.8
35	Wood Frm Vented Crawl Space 2	2.7	2.6	1.8
36	Wood Frm Vented Crawl Space 3	2.8	2.7	1.7
37	Wood Frm Vented Crawl Space 4	2.8	2.7	1.7
38	Wood Frm Vented Crawl Space 5	2.8	2.7	1.8
39	Wood Frm Vented Crawl Space 6	2.8	2.7	1.7
	Average SIR	**2.8**	**2.6**	**1.8**
	Max SIR	2.8	2.7	1.9
	Min SIR	2.6	2.3	1.3

Other metrics: Wood Frame Vented Crawl Space home Single pane wood windows		if include 1/3 of air inf savings
Annual cost savings	$246	$315
Measure Cost	$1,386	
Simple Payback	**5.6**	4.4
Energy Savings (Mbtu/yr)		
Initial home heat+cool	88.2	
Storm savings	17.8	
% reduction	**20%**	

Pittsburgh PA
Zone 5

HDD65	5968
CDD50	2836
Natural Gas ($/Mcf, 2012 avg)	$11.97
Electricity ($/kWh, 2012 avg)	$0.1282
Low-e Storms $7.85/ft2 + $30/window	

SIR with different primary window types:

	Home type	**Single pane wood/vinyl**	**Double pane metal**	**Double pane wood/vinyl**
1	Exposed Floor 1	1.8	1.7	1.3
2	Wood Frame Cape Cod 1 KW 1	1.8	1.7	1.3
3	Wood Frame Cape Cod 2 KW 2	1.9	1.8	1.3
4	Wood Frame Cape Cod 3 KW 3	1.9	1.8	1.3
5	Wood Frame Cape Cod 4 KW 4	1.9	1.8	1.1
6	Wood Frame Cape Cod 1 KW 5	1.8	1.8	1.4
7	Masonry 1	1.9	1.8	1.2
8	Masonry 2	1.9	1.8	1.2
9	Masonry 3	1.9	1.8	1.2
10	Masonry 4	1.9	1.8	1.2
11	Masonry 5	1.9	1.8	1.2
12	Masonry 6	1.9	1.8	1.2
13	Row House Masonry 1	1.6	1.5	--
14	Row House Masonry 2	1.6	1.5	--
15	Row House Wood Frame 1	1.5	1.5	--
16	Row House Wood Frame 2	1.6	1.5	--
17	Semi Detached Masonry 1	1.9	1.8	1.2
18	Semi Detached Masonry 2	1.9	1.8	1.3
19	Semi Detached Wood Frame 1	1.8	1.7	1.3
20	Semi Detached Wood Frame 2	1.8	1.8	1.3
21	Wood Frm Cond Bsmt 1	1.8	1.8	1.2
22	Wood Frm Cond Bsmt 2	1.9	1.8	1.2
23	Wood Frm Cond Bsmt 3	1.9	1.8	1.2
24	Wood Frm Cond Bsmt 4	1.9	1.8	1.1
25	Wood Frm Slab 1	1.9	1.8	1.2
26	Wood Frm Slab 2	1.9	1.8	1.2
27	Wood Frm Slab 3	1.9	1.8	1.2
28	Wood Frm Slab 4	1.9	1.8	1.1
29	Wood Frm Uncon Bsmt 1	1.8	1.7	1.3
30	Wood Frm Uncon Bsmt 2	1.8	1.7	1.3
31	Wood Frm Uncon Bsmt 3	1.8	1.7	1.3
32	Wood Frm Uncon Bsmt 4	1.8	1.7	1.3
33	Wood Frm Uncon Bsmt 5	1.8	1.7	1.3
34	Wood Frm Vented Crawl Space 1	1.8	1.7	1.3
35	Wood Frm Vented Crawl Space 2	1.8	1.7	1.3
36	Wood Frm Vented Crawl Space 3	1.8	1.7	1.3
37	Wood Frm Vented Crawl Space 4	1.8	1.7	1.2
38	Wood Frm Vented Crawl Space 5	1.8	1.7	1.3
39	Wood Frm Vented Crawl Space 6	1.9	1.8	1.2
	Average SIR	**1.8**	**1.7**	**1.2**
	Max SIR	1.9	1.8	1.4
	Min SIR	1.5	1.5	1.1

Other metrics:		if include 1/3 of air inf savings
Wood Frame Vented Crawl Space home		
Single pane wood windows		
Annual cost savings	$167	$211
Measure Cost	$1,386	
Simple Payback	**8.3**	6.6
Energy Savings (Mbtu/yr)		
Initial home heat+cool	69.8	
Storm savings	13.6	
% reduction	**19%**	

Chicago IL
Zone 5

HDD65	6176		
CDD50	3251		
Natural Gas ($/Mcf, 2012 avg)	$8.22	$0.804	per therm
Electricity ($/kWh, 2012 avg)	$0.1137		
Low-e Storms $7.85/ft2 + $30/window			

		Only 400 ft2 room air conditioned			**Whole home air conditioned**		
		SIR with different primary window types:			**SIR with different primary window types:**		
	Home type	**Single pane wood/vinyl**	**Double pane metal**	**Double pane wood/vinyl**	**Single pane wood/vinyl**	**Double pane metal**	**Double pane wood/vinyl**
1	Exposed Floor 1	1.4	1.6	--	1.3	1.3	--
2	Wood Frame Cape Cod 1 KW 1	1.4	1.6	--	1.3	1.3	--
3	Wood Frame Cape Cod 2 KW 2	1.4	1.6	--	1.3	1.3	--
4	Wood Frame Cape Cod 3 KW 3	1.4	1.6	--	1.3	1.3	--
5	Wood Frame Cape Cod 4 KW 4	1.4	1.6	--	1.3	1.3	--
6	Wood Frame Cape Cod 1 KW 5	1.5	1.4	--	1.3	1.3	--
7	Masonry 1	1.5	1.4	--	1.3	1.3	--
8	Masonry 2	1.6	1.4	--	1.4	1.3	--
9	Masonry 3	1.5	1.4	--	1.3	1.3	--
10	Masonry 4	1.5	1.4	--	1.4	1.3	--
11	Masonry 5	1.5	1.4	--	1.4	1.3	--
12	Masonry 6	1.3	1.3	--	1.4	1.3	--
13	Row House Masonry 1	1.1	1.0	--	1.3	1.3	--
14	Row House Masonry 2	1.1	1.0	--	1.3	1.3	--
15	Row House Wood Frame 1	1.3	1.4	--	1.3	1.2	--
16	Row House Wood Frame 2	1.3	1.2	--	1.3	1.3	--
17	Semi Detached Masonry 1	1.5	1.4	--	1.3	1.3	--
18	Semi Detached Masonry 2	1.5	1.5	--	1.4	1.3	--
19	Semi Detached Wood Frame 1	1.3	1.4	--	1.3	1.2	--
20	Semi Detached Wood Frame 2	1.4	1.3	--	1.3	1.3	--
21	Wood Frm Cond Bsmt 1	1.4	1.4	--	1.4	1.3	--
22	Wood Frm Cond Bsmt 2	1.4	1.4	--	1.4	1.3	--
23	Wood Frm Cond Bsmt 3	1.4	1.4	--	1.4	1.3	--
24	Wood Frm Cond Bsmt 4	1.3	1.3	--	1.4	1.3	--
25	Wood Frm Slab 1	1.4	1.4	--	1.4	1.3	--
26	Wood Frm Slab 2	1.4	1.4	--	1.4	1.3	--
27	Wood Frm Slab 3	1.4	1.4	--	1.4	1.3	--
28	Wood Frm Slab 4	1.4	1.4	--	1.4	1.3	--
29	Wood Frm Uncon Bsmt 1	1.4	1.5	--	1.3	1.3	--
30	Wood Frm Uncon Bsmt 2	1.5	1.4	--	1.3	1.3	--
31	Wood Frm Uncon Bsmt 3	1.4	1.6	--	1.3	1.3	--
32	Wood Frm Uncon Bsmt 4	1.4	1.6	--	1.3	1.3	--
33	Wood Frm Uncon Bsmt 5	1.4	1.6	--	1.3	1.3	--
34	Wood Frm Vented Crawl Space 1	1.4	1.6	--	1.3	1.3	--
35	Wood Frm Vented Crawl Space 2	1.5	1.4	--	1.3	1.3	--
36	Wood Frm Vented Crawl Space 3	1.4	1.6	--	1.3	1.3	--
37	Wood Frm Vented Crawl Space 4	1.3	1.6	--	1.3	1.3	--
38	Wood Frm Vented Crawl Space 5	1.4	1.6	--	1.3	1.3	--
39	Wood Frm Vented Crawl Space 6	1.4	1.3	--	1.3	1.3	--
	Average SIR	**1.4**	**1.4**	**--**	**1.3**	**1.3**	**--**
	Max SIR	1.6	1.6	--	1.4	1.3	--
	Min SIR	1.1	1.0	--	1.3	1.2	--

Slightly lower SIR because higher SEER for whole home AC (8 vs 6) yet still not much cooling

Other metrics: Wood Frame Vented Crawl Space home, Single pane wood windows		if include 1/3 of air inf savings
Annual cost savings	$120	$155
Measure Cost	$1,386	
Simple Payback	**11.6**	8.9
Energy Savings (Mbtu/yr)		
Initial home heat+cool	70.6	
Storm savings	14.2	
% reduction	**20%**	

Other metrics: Wood Frame Vented Crawl Space home, Single pane wood windows		if include 1/3 of air inf savings
Annual cost savings	$119	$152
Measure Cost	$1,386	
Simple Payback	**11.6**	9.1
Energy Savings (Mbtu/yr)		
Initial home heat+cool	76.4	
Storm savings	14.1	
% reduction	**18%**	

Denver CO
Zone 5

HDD65	6020
CDD50	2732
Natural Gas ($/Mcf, 2012 avg)	$8.26
Electricity ($/kWh, 2012 avg)	$0.1139
Low-e Storms $7.85/ft2 + $30/window	

SIR with different primary window types:

	Home type	Single pane wood/vinyl	Double pane metal	Double pane wood/vinyl
1	Exposed Floor 1	1.4	1.4	--
2	Wood Frame Cape Cod 1 KW 1	1.2	1.1	--
3	Wood Frame Cape Cod 2 KW 2	1.3	1.5	--
4	Wood Frame Cape Cod 3 KW 3	1.2	1.1	--
5	Wood Frame Cape Cod 4 KW 4	1.4	1.1	--
6	Wood Frame Cape Cod 1 KW 5	1.2	1.1	--
7	Masonry 1	1.4	1.3	--
8	Masonry 2	1.4	1.3	--
9	Masonry 3	1.4	1.3	--
10	Masonry 4	1.4	1.3	--
11	Masonry 5	1.2	1.2	--
12	Masonry 6	1.3	1.3	--
13	Row House Masonry 1	1.2	1.1	--
14	Row House Masonry 2	1.2	1.1	--
15	Row House Wood Frame 1	1.1	1.1	--
16	Row House Wood Frame 2	1.3	1.2	--
17	Semi Detached Masonry 1	1.4	1.4	--
18	Semi Detached Masonry 2	1.5	1.4	--
19	Semi Detached Wood Frame 1	1.4	1.3	--
20	Semi Detached Wood Frame 2	1.3	1.3	--
21	Wood Frm Cond Bsmt 1	1.2	1.1	--
22	Wood Frm Cond Bsmt 2	1.3	1.3	--
23	Wood Frm Cond Bsmt 3	1.3	1.3	--
24	Wood Frm Cond Bsmt 4	1.3	1.3	--
25	Wood Frm Slab 1	1.4	1.3	--
26	Wood Frm Slab 2	1.4	1.3	--
27	Wood Frm Slab 3	1.4	1.3	--
28	Wood Frm Slab 4	1.4	1.3	--
29	Wood Frm Uncon Bsmt 1	1.2	1.1	--
30	Wood Frm Uncon Bsmt 2	1.3	1.5	--
31	Wood Frm Uncon Bsmt 3	1.3	1.5	--
32	Wood Frm Uncon Bsmt 4	1.3	1.2	--
33	Wood Frm Uncon Bsmt 5	1.3	1.3	--
34	Wood Frm Vented Crawl Space 1	1.1	1.2	--
35	Wood Frm Vented Crawl Space 2	1.3	1.5	--
36	Wood Frm Vented Crawl Space 3	1.3	1.5	--
37	Wood Frm Vented Crawl Space 4	1.3	1.2	--
38	Wood Frm Vented Crawl Space 5	1.3	1.3	--
39	Wood Frm Vented Crawl Space 6	1.2	1.1	--
	Average SIR	**1.3**	**1.3**	**--**
	Max SIR	1.5	1.5	--
	Min SIR	1.1	1.1	--

Other metrics: Wood Frame Vented Crawl Space home Single pane wood windows		if include 1/3 of air inf savings
Annual cost savings	$70	$94
Measure Cost	$924	
Simple Payback	**13.2**	9.8
Energy Savings (Mbtu/yr)		
Initial home heat+cool	60.7	
Storm savings	10.6	<-- adjusted for all 4 sides using 75% of savings for south
% reduction	**18%**	not adjusted, it is 14%

Boise ID
Zone 5

HDD65	5861
CDD50	2807
Natural Gas ($/Mcf, 2012 avg)	$8.37
Electricity ($/kWh, 2012 avg)	$0.0847
Low-e Storms $7.85/ft2 + $30/window	

SIR with different primary window types:

	Home type	**Single pane wood/vinyl**	**Double pane metal**	**Double pane wood/vinyl**
1	Exposed Floor 1	1.2	1.2	--
2	Wood Frame Cape Cod 1 KW 1	1.3	1.3	--
3	Wood Frame Cape Cod 2 KW 2	1.3	1.3	--
4	Wood Frame Cape Cod 3 KW 3	1.3	1.3	--
5	Wood Frame Cape Cod 4 KW 4	1.3	1.3	--
6	Wood Frame Cape Cod 1 KW 5	1.4	1.3	--
7	Masonry 1	1.4	1.4	--
8	Masonry 2	1.5	1.2	--
9	Masonry 3	1.3	1.2	--
10	Masonry 4	1.4	1.4	--
11	Masonry 5	1.4	1.4	--
12	Masonry 6	1.3	1.2	--
13	Row House Masonry 1	--	--	--
14	Row House Masonry 2	--	--	--
15	Row House Wood Frame 1	--	1.2	--
16	Row House Wood Frame 2	1.3	1.2	--
17	Semi Detached Masonry 1	1.5	1.4	--
18	Semi Detached Masonry 2	1.5	1.4	--
19	Semi Detached Wood Frame 1	1.2	1.2	--
20	Semi Detached Wood Frame 2	1.3	1.2	--
21	Wood Frm Cond Bsmt 1	1.3	1.2	--
22	Wood Frm Cond Bsmt 2	1.3	1.2	--
23	Wood Frm Cond Bsmt 3	1.3	1.2	--
24	Wood Frm Cond Bsmt 4	1.3	1.2	--
25	Wood Frm Slab 1	1.3	1.2	--
26	Wood Frm Slab 2	1.3	1.2	--
27	Wood Frm Slab 3	1.3	1.2	--
28	Wood Frm Slab 4	1.2	1.2	--
29	Wood Frm Uncon Bsmt 1	1.3	1.2	--
30	Wood Frm Uncon Bsmt 2	1.2	1.3	--
31	Wood Frm Uncon Bsmt 3	1.2	1.2	--
32	Wood Frm Uncon Bsmt 4	1.2	1.2	--
33	Wood Frm Uncon Bsmt 5	1.2	1.2	--
34	Wood Frm Vented Crawl Space 1	1.2	1.2	--
35	Wood Frm Vented Crawl Space 2	1.2	1.3	--
36	Wood Frm Vented Crawl Space 3	1.2	1.2	--
37	Wood Frm Vented Crawl Space 4	1.2	1.3	--
38	Wood Frm Vented Crawl Space 5	1.2	1.2	--
39	Wood Frm Vented Crawl Space 6	1.3	1.1	--
	Average SIR	**1.3**	**1.2**	**--**
	Max SIR	1.5	1.4	--
	Min SIR	1.2	1.1	--

Other metrics: Wood Frame Vented Crawl Space home Single pane wood windows		if include 1/3 of air inf savings
Annual cost savings	$75	$100
Measure Cost	$924	
Simple Payback	**12.3**	9.2
Energy Savings (Mbtu/yr)		
Initial home heat+cool	60.5	
Storm savings	10.8	<-- adjusted for all 4 sides using 75% of savings for south
% reduction	**18%**	if not adjusted, it is 14%

New York NY
Zone 4

HDD65	4805	
CDD50	3634	**Note:** fuel prices in NYC are actually higher than these state average, so this is conservative
Natural Gas ($/Mcf, 2011 avg)	$13.71	(2012 avg not available)
Electricity ($/kWh, 2012 avg)	$0.1769	
Low-e Storms $7.85/ft2 + $30/window		

SIR with different primary window types:

	Home type	Single pane wood/vinyl	Double pane metal	Double pane wood/vinyl
1	Exposed Floor 1	2.1	2.0	1.4
2	Wood Frame Cape Cod 1 KW 1	2.1	2.0	1.4
3	Wood Frame Cape Cod 2 KW 2	2.1	2.0	1.4
4	Wood Frame Cape Cod 3 KW 3	2.1	2.0	1.4
5	Wood Frame Cape Cod 4 KW 4	2.1	2.0	1.4
6	Wood Frame Cape Cod 1 KW 5	2.2	2.1	1.4
7	Masonry 1	2.2	2.1	1.4
8	Masonry 2	2.2	2.0	1.4
9	Masonry 3	2.2	2.1	1.4
10	Masonry 4	2.2	2.1	1.4
11	Masonry 5	2.2	2.1	1.4
12	Masonry 6	2.2	2.1	1.4
13	Row House Masonry 1	1.7	1.6	1.2
14	Row House Masonry 2	1.7	1.6	1.2
15	Row House Wood Frame 1	2.0	2.0	1.3
16	Row House Wood Frame 2	2.1	2.0	1.4
17	Semi Detached Masonry 1	2.2	2.1	1.4
18	Semi Detached Masonry 2	2.2	2.1	1.5
19	Semi Detached Wood Frame 1	2.1	2.0	1.4
20	Semi Detached Wood Frame 2	2.2	2.1	1.5
21	Wood Frm Cond Bsmt 1	2.2	2.1	1.4
22	Wood Frm Cond Bsmt 2	2.2	2.1	1.5
23	Wood Frm Cond Bsmt 3	2.2	2.1	1.5
24	Wood Frm Cond Bsmt 4	2.2	2.1	1.5
25	Wood Frm Slab 1	2.2	2.1	1.5
26	Wood Frm Slab 2	2.2	2.1	1.5
27	Wood Frm Slab 3	2.2	2.1	1.5
28	Wood Frm Slab 4	2.2	2.2	1.5
29	Wood Frm Uncon Bsmt 1	2.1	2.0	1.4
30	Wood Frm Uncon Bsmt 2	2.1	2.0	1.4
31	Wood Frm Uncon Bsmt 3	2.1	2.0	1.4
32	Wood Frm Uncon Bsmt 4	2.1	2.0	1.4
33	Wood Frm Uncon Bsmt 5	2.1	2.0	1.4
34	Wood Frm Vented Crawl Space 1	2.1	2.0	1.4
35	Wood Frm Vented Crawl Space 2	2.1	2.0	1.4
36	Wood Frm Vented Crawl Space 3	2.1	2.0	1.4
37	Wood Frm Vented Crawl Space 4	2.1	2.1	1.4
38	Wood Frm Vented Crawl Space 5	2.1	2.0	1.4
39	Wood Frm Vented Crawl Space 6	2.2	2.1	1.4
	Average SIR	**2.1**	**2.0**	**1.4**
	Max SIR	2.2	2.2	1.5
	Min SIR	1.7	1.6	1.2

Other metrics: Wood Frame Vented Crawl Space home Single pane wood windows		if include 1/3 of air inf savings
Annual cost savings	$194	$252
Measure Cost	$1,386	
Simple Payback	**7.1**	5.5
Energy Savings (Mbtu/yr)		
Initial home heat+cool	61.6	
Storm savings	13.8	
% reduction	**22%**	

Washington DC
Zone 4

HDD65	4047	
CDD50	4391	
Natural Gas ($/Mcf, 2011 avg)	$13.06	(2012 avg not available)
Electricity ($/kWh, 2012 avg)	$0.1227	

Low-E Storms $7.85/ft2 + $30/window

Regular Low-E
Only 400 ft2 room air conditioned
SIR with different primary window types:

Home type	Single pane wood/vinyl	Double pane metal	Double pane wood/vinyl
1 Exposed Floor 1	1.4	1.3	--
2 Wood Frame Cape Cod 1 KW 1	1.3	1.3	--
3 Wood Frame Cape Cod 2 KW 2	1.4	1.3	--
4 Wood Frame Cape Cod 3 KW 3	1.3	1.3	--
5 Wood Frame Cape Cod 4 KW 4	1.4	1.3	--
6 Wood Frame Cape Cod 1 KW 5	1.4	1.3	--
7 Masonry 1	1.4	1.3	--
8 Masonry 2	1.4	1.3	--
9 Masonry 3	1.4	1.3	--
10 Masonry 4	1.4	1.3	--
11 Masonry 5	1.4	1.4	--
12 Masonry 6	1.4	1.3	--
13 Row House Masonry 1	1.3	1.3	--
14 Row House Masonry 2	1.3	1.3	--
15 Row House Wood Frame 1	1.3	1.2	--
16 Row House Wood Frame 2	1.3	1.3	--
17 Semi Detached Masonry 1	1.4	1.3	--
18 Semi Detached Masonry 2	1.4	1.3	--
19 Semi Detached Wood Frame 1	1.4	1.3	--
20 Semi Detached Wood Frame 2	1.4	1.3	--
21 Wood Frm Cond Bsmt 1	1.4	1.3	--
22 Wood Frm Cond Bsmt 2	1.4	1.3	--
23 Wood Frm Cond Bsmt 3	1.4	1.3	--
24 Wood Frm Cond Bsmt 4	1.4	1.3	--
25 Wood Frm Slab 1	1.4	1.4	--
26 Wood Frm Slab 2	1.4	1.4	--
27 Wood Frm Slab 3	1.4	1.4	--
28 Wood Frm Slab 4	1.5	1.4	--
29 Wood Frm Uncon Bsmt 1	1.4	1.3	--
30 Wood Frm Uncon Bsmt 2	1.4	1.3	--
31 Wood Frm Uncon Bsmt 3	1.4	1.3	--
32 Wood Frm Uncon Bsmt 4	1.4	1.3	--
33 Wood Frm Uncon Bsmt 5	1.4	1.3	--
34 Wood Frm Vented Crawl Space 1	1.4	1.3	--
35 Wood Frm Vented Crawl Space 2	1.4	1.3	--
36 Wood Frm Vented Crawl Space 3	1.4	1.3	--
37 Wood Frm Vented Crawl Space 4	1.4	1.3	--
38 Wood Frm Vented Crawl Space 5	1.4	1.3	--
39 Wood Frm Vented Crawl Space 6	1.5	1.4	--
Average SIR	**1.4**	**1.3**	--
Max SIR	1.5	1.4	--
Min SIR	1.3	1.2	--

Regular Low-E
Whole home air conditioned
SIR with different primary window types:

Home type	Single pane wood/vinyl	Double pane metal	Double pane wood/vinyl
1 Exposed Floor 1	1.5	1.5	1.2
2 Wood Frame Cape Cod 1 KW 1	1.5	1.5	1.2
3 Wood Frame Cape Cod 2 KW 2	1.5	1.4	1.1
4 Wood Frame Cape Cod 3 KW 3	1.5	1.4	1.1
5 Wood Frame Cape Cod 4 KW 4	1.5	1.4	1.1
6 Wood Frame Cape Cod 1 KW 5	1.6	1.6	1.1
7 Masonry 1	1.6	1.6	1.1
8 Masonry 2	1.6	1.5	1.1
9 Masonry 3	1.6	1.5	1.1
10 Masonry 4	1.6	1.6	1.1
11 Masonry 5	1.7	1.6	1.2
12 Masonry 6	1.6	1.6	1.1
13 Row House Masonry 1	1.5	1.5	1.0
14 Row House Masonry 2	1.5	1.4	1.1
15 Row House Wood Frame 1	1.4	1.4	--
16 Row House Wood Frame 2	1.5	1.5	1.1
17 Semi Detached Masonry 1	1.5	1.5	1.1
18 Semi Detached Masonry 2	1.6	1.6	1.1
19 Semi Detached Wood Frame 1	1.4	1.4	1.1
20 Semi Detached Wood Frame 2	1.5	1.5	1.0
21 Wood Frm Cond Bsmt 1	1.6	1.6	1.1
22 Wood Frm Cond Bsmt 2	1.6	1.5	1.1
23 Wood Frm Cond Bsmt 3	1.6	1.5	1.1
24 Wood Frm Cond Bsmt 4	1.6	1.5	1.1
25 Wood Frm Slab 1	1.6	1.6	1.1
26 Wood Frm Slab 2	1.6	1.5	1.1
27 Wood Frm Slab 3	1.6	1.5	1.1
28 Wood Frm Slab 4	1.6	1.5	1.1
29 Wood Frm Uncon Bsmt 1	1.6	1.5	1.1
30 Wood Frm Uncon Bsmt 2	1.5	1.5	1.1
31 Wood Frm Uncon Bsmt 3	1.5	1.5	1.1
32 Wood Frm Uncon Bsmt 4	1.5	1.5	1.2
33 Wood Frm Uncon Bsmt 5	1.6	1.5	1.1
34 Wood Frm Vented Crawl Space 1	1.5	1.5	1.2
35 Wood Frm Vented Crawl Space 2	1.5	1.5	1.1
36 Wood Frm Vented Crawl Space 3	1.5	1.5	1.1
37 Wood Frm Vented Crawl Space 4	1.5	1.5	1.1
38 Wood Frm Vented Crawl Space 5	1.6	1.5	1.1
39 Wood Frm Vented Crawl Space 6	1.6	1.5	1.1
Average SIR	**1.5**	**1.5**	**1.1**
Max SIR	1.7	1.6	1.2
Min SIR	1.4	1.4	1

Solar Control Low-E
Whole home air conditioned
SIR with different primary window type

Home type	Single pane wood/vinyl	Double pane metal	pane wood/vinyl
1 Exposed Floor 1	1.7	1.7	1.2
2 Wood Frame Cape Cod 1 KW 1	1.7	1.7	1.2
3 Wood Frame Cape Cod 2 KW 2	1.6	1.5	1.1
4 Wood Frame Cape Cod 3 KW 3	1.6	1.5	1.1
5 Wood Frame Cape Cod 4 KW 4	1.6	1.5	1.1
6 Wood Frame Cape Cod 1 KW 5	1.7	1.7	1.3
7 Masonry 1	1.7	1.7	1.3
8 Masonry 2	1.6	1.6	1.2
9 Masonry 3	1.7	1.6	1.2
10 Masonry 4	1.7	1.7	1.3
11 Masonry 5	1.7	1.7	1.3
12 Masonry 6	1.7	1.6	1.2
13 Row House Masonry 1	1.5	1.4	1.1
14 Row House Masonry 2	1.5	1.4	1.1
15 Row House Wood Frame 1	1.4	1.4	1.0
16 Row House Wood Frame 2	1.5	1.4	1.1
17 Semi Detached Masonry 1	1.6	1.5	1.1
18 Semi Detached Masonry 2	1.6	1.5	1.2
19 Semi Detached Wood Frame 1	1.5	1.5	1.1
20 Semi Detached Wood Frame 2	1.5	1.5	1.1
21 Wood Frm Cond Bsmt 1	1.7	1.7	1.3
22 Wood Frm Cond Bsmt 2	1.6	1.6	1.2
23 Wood Frm Cond Bsmt 3	1.6	1.6	1.2
24 Wood Frm Cond Bsmt 4	1.6	1.6	1.2
25 Wood Frm Slab 1	1.7	1.7	1.3
26 Wood Frm Slab 2	1.6	1.6	1.2
27 Wood Frm Slab 3	1.6	1.6	1.2
28 Wood Frm Slab 4	1.6	1.6	1.2
29 Wood Frm Uncon Bsmt 1	1.7	1.7	1.3
30 Wood Frm Uncon Bsmt 2	1.6	1.5	1.2
31 Wood Frm Uncon Bsmt 3	1.6	1.5	1.2
32 Wood Frm Uncon Bsmt 4	1.7	1.7	1.2
33 Wood Frm Uncon Bsmt 5	1.7	1.7	1.3
34 Wood Frm Vented Crawl Space 1	1.7	1.7	1.2
35 Wood Frm Vented Crawl Space 2	1.6	1.5	1.2
36 Wood Frm Vented Crawl Space 3	1.6	1.5	1.2
37 Wood Frm Vented Crawl Space 4	1.6	1.5	1.2
38 Wood Frm Vented Crawl Space 5	1.7	1.7	1.3
39 Wood Frm Vented Crawl Space 6	1.6	1.6	1.2
Average SIR	**1.6**	**1.6**	**1.2**
Max SIR	1.7	1.7	1.3
Min SIR	1.4	1.4	1

Other metrics: Wood Frame Vented Crawl Space home Single pane wood windows		if include 1/3 of air inf savings
Annual cost savings	$126	$161.67
Measure Cost	$1,386	
Simple Payback	**11.0**	8.6
Energy Savings (Mbtu/yr)		
Initial home heat+cool	47.0	
Storm savings	9.3	
% reduction	**20%**	

Other metrics: Wood Frame Vented Crawl Space home Single pane wood windows		if include 1/3 of air inf savings
Annual cost savings	$140	$178
Measure Cost	$1,386	
Simple Payback	**9.9**	7.8
Energy Savings (Mbtu/yr)		
Initial home heat+cool	54.7	
Storm savings	9.7	
% reduction	**18%**	

Site energy

Other metrics: Wood Frame Vented Crawl Space home Single pane wood windows		if include 1/3 of air inf savings
Annual cost savings	$149	$187
Measure Cost	$1,386	
Simple Payback	**9.3**	7.4
Energy Savings (Mbtu/yr)		
Initial home heat+cool	54.7	
Storm savings	9.0	
% reduction	**16%**	

Lower site energy % savings, but slightly higher SIR because cost diff

Raleigh NC
Zone 4

HDD65	3457			
CDD50	4499			
Natural Gas ($/Mcf, 2011 avg)	$12.55	(2012 avg not available)	$1.227	per therm
Electricity ($/kWh, 2012 avg)	$0.1081			
Low-e Storms $7.85/ft2 + $30/window				

		NG furnace, central AC with standard Low-e SIR with different primary window types:			NG furnace, central AC with Solar Control Low-e SIR with different primary window types:		
	Home type	**Single pane wood/vinyl**	**Double pane metal**	**Double pane wood/vinyl**	**Single pane wood/vinyl**	**Double pane metal**	**Double pane wood/vinyl**
1	Exposed Floor 1	1.1	1.2	--	1.3	1.3	1.0
2	Wood Frame Cape Cod 1 KW 1	1.1	1.2	--	1.3	1.3	1.0
3	Wood Frame Cape Cod 2 KW 2	1.1	1.2	--	1.2	1.2	1.0
4	Wood Frame Cape Cod 3 KW 3	1.1	1.2	--	1.2	1.2	1.0
5	Wood Frame Cape Cod 4 KW 4	1.1	1.2	--	1.2	1.2	1.0
6	Wood Frame Cape Cod 1 KW 5	1.2	1.2	--	1.2	1.3	1.0
7	Masonry 1	1.2	1.1	--	1.3	1.2	1.0
8	Masonry 2	1.2	1.1	--	1.3	1.2	1.0
9	Masonry 3	1.2	1.1	--	1.3	1.2	1.0
10	Masonry 4	1.2	1.2	--	1.3	1.2	1.0
11	Masonry 5	1.2	1.2	--	1.3	1.4	1.0
12	Masonry 6	1.2	1.2	--	1.3	1.4	1.0
13	Row House Masonry 1	1.1	1.1	--	1.2	1.1	--
14	Row House Masonry 2	1.1	1.1	--	1.2	1.2	--
15	Row House Wood Frame 1	1.0	1.0	--	1.1	1.1	--
16	Row House Wood Frame 2	1.1	1.1	--	1.2	1.2	--
17	Semi Detached Masonry 1	1.2	1.1	--	1.2	1.2	1.0
18	Semi Detached Masonry 2	1.2	1.2	--	1.2	1.4	--
19	Semi Detached Wood Frame 1	1.1	1.1	--	1.2	1.2	1.0
20	Semi Detached Wood Frame 2	1.1	1.1	--	1.2	1.2	--
21	Wood Frm Cond Bsmt 1	1.2	1.2	--	1.3	1.3	1.0
22	Wood Frm Cond Bsmt 2	1.2	1.1	--	1.2	1.2	1.0
23	Wood Frm Cond Bsmt 3	1.2	1.1	--	1.2	1.2	1.0
24	Wood Frm Cond Bsmt 4	1.2	1.1	--	1.2	1.2	1.0
25	Wood Frm Slab 1	1.2	1.2	--	1.5	1.5	--
26	Wood Frm Slab 2	1.2	1.2	--	1.4	1.4	1.0
27	Wood Frm Slab 3	1.2	1.2	--	1.4	1.4	--
28	Wood Frm Slab 4	1.2	1.2	--	1.4	1.4	--
29	Wood Frm Uncon Bsmt 1	1.2	1.3	--	1.3	1.3	1.0
30	Wood Frm Uncon Bsmt 2	1.1	1.1	--	1.2	1.2	1.0
31	Wood Frm Uncon Bsmt 3	1.1	1.1	--	1.2	1.2	1.0
32	Wood Frm Uncon Bsmt 4	1.2	1.2	--	1.3	1.3	1.0
33	Wood Frm Uncon Bsmt 5	1.2	1.2	--	1.3	1.3	1.0
34	Wood Frm Vented Crawl Space 1	1.1	1.2	--	1.3	1.3	1.0
35	Wood Frm Vented Crawl Space 2	1.1	1.1	--	1.2	1.2	1.0
36	Wood Frm Vented Crawl Space 3	1.1	1.1	--	1.2	1.2	1.0
37	Wood Frm Vented Crawl Space 4	1.1	1.1	--	1.2	1.2	1.0
38	Wood Frm Vented Crawl Space 5	1.2	1.2	--	1.3	1.3	1.0
39	Wood Frm Vented Crawl Space 6	1.1	1.1	--	1.3	1.2	1.0
	Average SIR	**1.2**	**1.2**	**--**	**1.3**	**1.3**	**1.0**
	Max SIR	1.2	1.3	--	1.5	1.5	1.0
	Min SIR	1.0	1.0	--	1.1	1.1	1.0

Often only specify east / west

Other metrics: Wood Frame Vented Crawl Space home, Single pane wood windows		if include 1/3 of air inf savings
Annual cost savings	$103	$130
Measure Cost	$1,386	
Simple Payback	**13.5**	10.6
Energy Savings (Mbtu/yr)		
Initial home heat+cool	45.3	
Storm savings	7.4	
% reduction	**16%**	

Other metrics: Wood Frame Vented Crawl Space home, Single pane wood windows		if include 1/3 of air inf savings
Annual cost savings	$113	$140
Measure Cost	$1,386	
Simple Payback	**12.3**	9.9
Energy Savings (Mbtu/yr)		
Initial home heat+cool	45.3	
Storm savings	7.1	
% reduction	**16%**	

Kansas City MO
Zone 4

HDD65	5393		
CDD50	3852		
Natural Gas ($/Mcf, 2012 avg)	$12.31	$1.203	per therm
Electricity ($/kWh, 2012 avg)	$0.1007		
Low-e Storms $7.85/ft2 + $30/window			

		Only 400 ft2 room air conditioned SIR with different primary window types:			**Whole home air conditioned** SIR with different primary window types:		
	Home type	**Single pane wood/vinyl**	**Double pane metal**	**Double pane wood/vinyl**	**Single pane wood/vinyl**	**Double pane metal**	**Double pane wood/vinyl**
1	Exposed Floor 1	1.5	1.4	1.0	1.7	1.7	1.2
2	Wood Frame Cape Cod 1 KW 1	1.5	1.4	--	1.7	1.6	1.2
3	Wood Frame Cape Cod 2 KW 2	1.5	1.4	--	1.6	1.6	1.1
4	Wood Frame Cape Cod 3 KW 3	1.5	1.4	--	1.7	1.6	1.2
5	Wood Frame Cape Cod 4 KW 4	1.5	1.4	--	1.6	1.7	1.1
6	Wood Frame Cape Cod 1 KW 5	1.5	1.4	--	1.8	1.7	1.2
7	Masonry 1	1.5	1.4	1.1	1.8	1.7	1.2
8	Masonry 2	1.5	1.4	1.0	1.7	1.7	1.2
9	Masonry 3	1.4	1.4	1.0	1.7	1.7	1.2
10	Masonry 4	1.5	1.4	1.1	1.8	1.7	1.2
11	Masonry 5	1.5	1.4	1.1	1.8	1.8	1.2
12	Masonry 6	*1.4*	*1.4*	*1.0*	1.8	1.7	1.2
13	Row House Masonry 1	1.4	1.3	1.0	1.7	1.6	1.1
14	Row House Masonry 2	1.4	1.3	1.0	1.7	1.6	1.1
15	Row House Wood Frame 1	1.4	1.3	--	1.6	1.5	1.1
16	Row House Wood Frame 2	1.4	1.3	1.0	1.7	1.6	1.2
17	Semi Detached Masonry 1	1.5	1.4	1.1	1.8	1.7	1.2
18	Semi Detached Masonry 2	1.5	1.4	1.1	1.8	1.7	1.2
19	Semi Detached Wood Frame 1	1.5	1.4	--	1.7	1.6	1.1
20	Semi Detached Wood Frame 2	1.5	1.4	1.2	1.7	1.7	1.2
21	Wood Frm Cond Bsmt 1	1.5	1.4	1.1	1.8	1.7	1.2
22	Wood Frm Cond Bsmt 2	1.5	1.4	1.1	1.7	1.7	1.2
23	Wood Frm Cond Bsmt 3	1.5	1.5	1.1	1.7	1.7	1.2
24	Wood Frm Cond Bsmt 4	1.5	1.5	1.1	1.7	1.7	1.2
25	Wood Frm Slab 1	1.5	1.4	1.1	1.8	1.7	1.2
26	Wood Frm Slab 2	1.5	1.5	1.1	1.7	1.7	1.2
27	Wood Frm Slab 3	1.5	1.5	1.1	1.7	1.7	1.2
28	Wood Frm Slab 4	1.5	1.5	1.1	1.7	1.7	1.2
29	Wood Frm Uncon Bsmt 1	1.5	1.4	--	1.7	1.6	1.1
30	Wood Frm Uncon Bsmt 2	1.5	1.4	1.0	1.7	1.6	1.1
31	Wood Frm Uncon Bsmt 3	1.5	1.4	1.0	1.7	1.6	1.1
32	Wood Frm Uncon Bsmt 4	1.5	1.4	1.0	1.7	1.7	1.2
33	Wood Frm Uncon Bsmt 5	1.5	1.4	1.0	1.7	1.7	1.2
34	Wood Frm Vented Crawl Space 1	1.5	1.4	1.0	1.7	1.7	1.2
35	Wood Frm Vented Crawl Space 2	1.5	1.4	1.0	1.7	1.6	1.1
36	Wood Frm Vented Crawl Space 3	1.5	1.4	1.0	1.7	1.6	1.1
37	Wood Frm Vented Crawl Space 4	1.5	1.4	1.0	1.7	1.6	1.1
38	Wood Frm Vented Crawl Space 5	1.5	1.4	1.0	1.7	1.7	1.2
39	Wood Frm Vented Crawl Space 6	1.5	1.4	1.0	1.7	1.7	1.2
	Average SIR	**1.5**	**1.4**	**1.0**	**1.7**	**1.7**	**1.2**
	Max SIR	1.5	1.5	1.2	1.8	1.8	1.2
	Min SIR	1.4	1.3	1	1.6	1.5	1.1

Other metrics: Wood Frame Vented Crawl Space home Single pane wood windows		if include 1/3 of air inf savings
Annual cost savings	$136	$174
Measure Cost	$1,386	
Simple Payback	**10.2**	8.0
Energy Savings (Mbtu/yr)		
Initial home heat+cool	55.5	
Storm savings	10.7	
% reduction	**19%**	

Other metrics: Wood Frame Vented Crawl Space home Single pane wood windows		if include 1/3 of air inf savings
Annual cost savings	$155	$196
Measure Cost	$1,386	
Simple Payback	**8.9**	7.1
Energy Savings (Mbtu/yr)		
Initial home heat+cool	65.1	
Storm savings	11.4	
% reduction	**18%**	

Seattle WA
Zone 4

HDD65	4908
CDD50	2021
Natural Gas ($/Mcf, 2012 avg)	$11.89
Electricity ($/kWh, 2012 avg)	$0.0853
Low-e Storms $7.85/ft2 + $30/window	

SIR with different primary window types:

	Home type	**Single pane wood/vinyl**	**Double pane metal**	**Double pane wood/vinyl**
1	Exposed Floor 1	1.4	1.3	--
2	Wood Frame Cape Cod 1 KW 1	1.4	1.3	--
3	Wood Frame Cape Cod 2 KW 2	1.4	1.3	--
4	Wood Frame Cape Cod 3 KW 3	1.4	1.3	--
5	Wood Frame Cape Cod 4 KW 4	1.4	1.3	--
6	Wood Frame Cape Cod 1 KW 5	1.4	1.4	--
7	Masonry 1	1.5	1.4	1.0
8	Masonry 2	1.5	1.4	--
9	Masonry 3	1.5	1.4	--
10	Masonry 4	1.5	1.4	--
11	Masonry 5	1.5	1.4	1.0
12	Masonry 6	1.5	1.4	1.0
13	Row House Masonry 1	1.5	1.4	1.0
14	Row House Masonry 2	1.5	1.4	1.0
15	Row House Wood Frame 1	1.3	1.3	--
16	Row House Wood Frame 2	1.5	1.4	1.0
17	Semi Detached Masonry 1	1.5	1.4	1.0
18	Semi Detached Masonry 2	1.5	1.4	1.0
19	Semi Detached Wood Frame 1	1.4	1.3	--
20	Semi Detached Wood Frame 2	1.4	1.4	--
21	Wood Frm Cond Bsmt 1	1.5	1.4	1.0
22	Wood Frm Cond Bsmt 2	1.5	1.4	1.0
23	Wood Frm Cond Bsmt 3	1.5	1.4	1.0
24	Wood Frm Cond Bsmt 4	1.5	1.4	1.0
25	Wood Frm Slab 1	1.5	1.4	1.0
26	Wood Frm Slab 2	1.5	1.4	1.0
27	Wood Frm Slab 3	1.5	1.4	--
28	Wood Frm Slab 4	1.5	1.4	--
29	Wood Frm Uncon Bsmt 1	1.4	1.3	--
30	Wood Frm Uncon Bsmt 2	1.4	1.3	--
31	Wood Frm Uncon Bsmt 3	1.4	1.3	--
32	Wood Frm Uncon Bsmt 4	1.4	1.3	--
33	Wood Frm Uncon Bsmt 5	1.4	1.4	--
34	Wood Frm Vented Crawl Space 1	1.4	1.3	--
35	Wood Frm Vented Crawl Space 2	1.4	1.3	--
36	Wood Frm Vented Crawl Space 3	1.4	1.3	--
37	Wood Frm Vented Crawl Space 4	1.4	1.4	--
38	Wood Frm Vented Crawl Space 5	1.4	1.4	--
39	Wood Frm Vented Crawl Space 6	1.5	1.4	--
	Average SIR	**1.4**	**1.4**	**--**
	Max SIR	1.5	1.4	--
	Min SIR	1.3	1.3	--

Other metrics: Wood Frame Vented Crawl Space home Single pane wood windows		if include 1/3 of air inf savings
Annual cost savings	$130	$166
Measure Cost	$1,386	
Simple Payback	**10.7**	8.4
Energy Savings (Mbtu/yr)		
Initial home heat+cool	51.0	
Storm savings	11.0	
% reduction	**22%**	

Atlanta GA
Zone 3

HDD65	2991			
CDD50	5038			
Natural Gas ($/Mcf, 2011 avg)	$15.72	(2012 avg not available)	$1.537	per therm
Electricity ($/kWh, 2012 avg)	$0.1100			
Low-e Storms $7.85/ft2 + $30/window				

		NG furnace, central AC with standard Low-e SIR with different primary window types:			NG furnace, central AC with Solar Control Low-e SIR with different primary window types:		
	Home type	**Single pane wood/vinyl**	**Double pane metal**	**Double pane wood/vinyl**	**Single pane wood/vinyl**	**Double pane metal**	**Double pane wood/vinyl**
1	Exposed Floor 1	1.2	1.2	--	1.4	1.4	1.3
2	Wood Frame Cape Cod 1 KW 1	1.2	1.2	--	1.4	1.4	1.3
3	Wood Frame Cape Cod 2 KW 2	1.2	1.2	--	1.3	1.4	1.1
4	Wood Frame Cape Cod 3 KW 3	1.2	1.2	--	1.3	1.4	1.1
5	Wood Frame Cape Cod 4 KW 4	1.2	1.2	--	1.3	1.4	1.1
6	Wood Frame Cape Cod 1 KW 5	1.3	1.3	--	1.5	1.4	1.3
7	Masonry 1	1.3	1.3	--	1.5	1.5	1.3
8	Masonry 2	1.3	1.2	--	1.4	1.3	1.1
9	Masonry 3	1.3	1.2	--	1.4	1.3	1.1
10	Masonry 4	1.3	1.3	--	1.5	1.5	1.3
11	Masonry 5	1.4	1.4	1.1	1.5	1.4	1.2
12	Masonry 6	1.3	1.3	--	1.4	1.4	1.1
13	Row House Masonry 1	1.2	1.2	--	1.2	1.2	--
14	Row House Masonry 2	1.2	1.1	--	1.2	1.2	--
15	Row House Wood Frame 1	1.1	1.1	--	1.2	1.2	--
16	Row House Wood Frame 2	1.2	1.2	--	1.2	1.2	--
17	Semi Detached Masonry 1	1.2	1.3	--	1.3	1.4	1.1
18	Semi Detached Masonry 2	1.3	1.3	--	1.4	1.3	1.1
19	Semi Detached Wood Frame 1	1.1	1.1	--	1.3	1.2	1.1
20	Semi Detached Wood Frame 2	1.2	1.2	--	1.3	1.3	1.1
21	Wood Frm Cond Bsmt 1	1.3	1.3	--	1.4	1.4	1.3
22	Wood Frm Cond Bsmt 2	1.3	1.2	--	1.4	1.3	1.1
23	Wood Frm Cond Bsmt 3	1.3	1.2	--	1.3	1.3	1.1
24	Wood Frm Cond Bsmt 4	1.3	1.2	--	1.4	1.3	1.1
25	Wood Frm Slab 1	1.3	1.3	--	1.4	1.4	1.3
26	Wood Frm Slab 2	1.3	1.3	--	1.4	1.3	1.1
27	Wood Frm Slab 3	1.3	1.2	--	1.4	1.3	1.1
28	Wood Frm Slab 4	1.3	1.3	--	1.4	1.3	1.1
29	Wood Frm Uncon Bsmt 1	1.2	1.2	--	1.4	1.4	1.3
30	Wood Frm Uncon Bsmt 2	1.2	1.2	--	1.3	1.3	1.1
31	Wood Frm Uncon Bsmt 3	1.2	1.2	--	1.3	1.3	1.1
32	Wood Frm Uncon Bsmt 4	1.2	1.2	--	1.4	1.4	1.3
33	Wood Frm Uncon Bsmt 5	1.3	1.2	--	1.4	1.4	1.3
34	Wood Frm Vented Crawl Space 1	1.2	1.2	--	1.4	1.4	1.3
35	Wood Frm Vented Crawl Space 2	1.2	1.2	--	1.3	1.3	1.1
36	Wood Frm Vented Crawl Space 3	1.2	1.2	--	1.3	1.3	1.1
37	Wood Frm Vented Crawl Space 4	1.2	1.2	--	1.3	1.3	1.1
38	Wood Frm Vented Crawl Space 5	1.3	1.2	--	1.4	1.4	1.3
39	Wood Frm Vented Crawl Space 6	1.2	1.2	--	1.4	1.3	1.1
	Average SIR	**1.2**	**1.2**	**--**	**1.4**	**1.3**	**1.2**
	Max SIR	1.4	1.4	--	1.5	1.5	1.3
	Min SIR	1.1	1.1	--	1.2	1.2	1.1

But only if solar screens unselected (SIR ~ 2.3)
Often only specify east / west

Other metrics: Wood Frame Vented Crawl Space home Single pane wood windows		if include 1/3 of air inf savings
Annual cost savings	$112	$143
Measure Cost	$1,386	
Simple Payback	**12.4**	9.7
Energy Savings (Mbtu/yr)		
Initial home heat+cool	41.0	
Storm savings	6.6	
% reduction	**16%**	

Other metrics: Wood Frame Vented Crawl Space home Single pane wood windows		if include 1/3 of air inf savings
Annual cost savings	$124	$155
Measure Cost	$1,386	
Simple Payback	**11.2**	9.0
Energy Savings (Mbtu/yr)		
Initial home heat+cool	41.0	
Storm savings	6.4	
% reduction	**16%**	

Dallas TX
Zone 3
HDD65 2259
CDD50 6587
Natural Gas ($/Mcf, 2012 avg) $10.90
Electricity ($/kWh, 2012 avg) $0.1104
Low-E Storms $7.85/ft2 + $30/window

NG furnace, central AC with standard Low-E

SIR with different primary window types:

Home type	Single pane wood/vinyl	Double pane metal	Double pane wood/vinyl
1 Exposed Floor 1	1.1	1.1	—
2 Wood Frame Cape Cod 1 KW 1	1.1	1.3	—
3 Wood Frame Cape Cod 2 KW 2	1.1	1.3	—
4 Wood Frame Cape Cod 3 KW 3	1.1	1.3	—
5 Wood Frame Cape Cod 4 KW 4	1.1	1.3	—
6 Wood Frame Cape Cod 1 KW 5	1.2	1.2	—
7 Masonry 1	1.1	1.2	—
8 Masonry 2	1.2	1.3	—
9 Masonry 3	1.3	1.3	—
10 Masonry 4	1.1	1.1	—
11 Masonry 5	1.2	1.2	—
12 Masonry 6	1.5	1.5	—
13 Row House Masonry 1	1.1	1.0	—
14 Row House Masonry 2	1.1	1.1	—
15 Row House Wood Frame 1	1.1	1.2	—
16 Row House Wood Frame 2	1.3	1.2	—
17 Semi Detached Masonry 1	1.1	1.1	—
18 Semi Detached Masonry 2	1.2	1.2	—
19 Semi Detached Wood Frame 1	1.1	1.1	—
20 Semi Detached Wood Frame 2	1.2	1.1	—
21 Wood Frm Cond Bsmt 1	1.2	1.2	—
22 Wood Frm Cond Bsmt 2	1.2	1.2	—
23 Wood Frm Cond Bsmt 3	1.2	1.2	—
24 Wood Frm Cond Bsmt 4	1.2	1.2	—
25 Wood Frm Slab 1	1.1	1.1	—
26 Wood Frm Slab 2	1.1	1.1	—
27 Wood Frm Slab 3	1.1	1.1	—
28 Wood Frm Slab 4	1.2	1.1	—
29 Wood Frm Uncon Bsmt 1	1.2	1.2	—
30 Wood Frm Uncon Bsmt 2	1.2	1.2	—
31 Wood Frm Uncon Bsmt 3	1.2	1.1	—
32 Wood Frm Uncon Bsmt 4	1.2	1.1	—
33 Wood Frm Uncon Bsmt 5	1.1	1.1	—
34 Wood Frm Vented Crawl Space 1	1.1	1.1	—
35 Wood Frm Vented Crawl Space 2	1.1	1.1	—
36 Wood Frm Vented Crawl Space 3	1.1	1.1	—
37 Wood Frm Vented Crawl Space 4	1.2	1.1	—
38 Wood Frm Vented Crawl Space 5	1.1	1.1	—
39 Wood Frm Vented Crawl Space 6	1.4	1.4	—
Average SIR	**1.2**	**1.2**	—
Max SIR	1.5	1.5	—
Min SIR	1.1	1.0	—

But only if solar screens unselected
Several S/E/W or E/W only

Other metrics: Wood Frame Vented Crawl Space home, Single pane wood windows		if include 1/3 of air inf savings
Annual cost savings	$86	$121
Measure Cost	$924	
Simple Payback	**10.7**	7.6
Energy Savings (Mbtu/yr)		
Initial home heat+cool	45.7	
Storm savings	4.9	
% reduction	**11%**	

NG furnace, central AC with Solar Control Low-E

SIR with different primary window types:

Home type	Single pane wood/vinyl	Double pane metal	Double pane wood/vinyl
1 Exposed Floor 1	1.3	1.3	1.1
2 Wood Frame Cape Cod 1 KW 1	1.4	1.4	1.1
3 Wood Frame Cape Cod 2 KW 2	1.4	1.4	1.1
4 Wood Frame Cape Cod 3 KW 3	1.4	1.4	1.1
5 Wood Frame Cape Cod 4 KW 4	1.4	1.4	1.1
6 Wood Frame Cape Cod 1 KW 5	1.5	1.5	1.1
7 Masonry 1	1.5	1.5	1.1
8 Masonry 2	1.5	1.7	1.6
9 Masonry 3	1.7	1.7	1.6
10 Masonry 4	1.4	1.4	1.1
11 Masonry 5	1.5	1.5	1.1
12 Masonry 6	1.7	1.7	1.6
13 Row House Masonry 1	1.2	1.2	—
14 Row House Masonry 2	1.2	1.2	—
15 Row House Wood Frame 1	1.3	1.3	1.1
16 Row House Wood Frame 2	1.4	1.3	1.0
17 Semi Detached Masonry 1	1.4	1.4	1.1
18 Semi Detached Masonry 2	1.4	1.4	1.1
19 Semi Detached Wood Frame 1	1.4	1.3	1.1
20 Semi Detached Wood Frame 2	1.5	1.3	1.1
21 Wood Frm Cond Bsmt 1	1.3	1.3	1.1
22 Wood Frm Cond Bsmt 2	1.5	1.5	1.1
23 Wood Frm Cond Bsmt 3	1.5	1.5	1.1
24 Wood Frm Cond Bsmt 4	1.5	1.5	1.1
25 Wood Frm Slab 1	1.3	1.3	1.1
26 Wood Frm Slab 2	1.4	1.4	1.1
27 Wood Frm Slab 3	1.4	1.4	1.1
28 Wood Frm Slab 4	1.4	1.4	1.1
29 Wood Frm Uncon Bsmt 1	1.3	1.3	1.1
30 Wood Frm Uncon Bsmt 2	1.4	1.4	1.1
31 Wood Frm Uncon Bsmt 3	1.4	1.4	1.1
32 Wood Frm Uncon Bsmt 4	1.3	1.3	1.1
33 Wood Frm Uncon Bsmt 5	1.3	1.3	1.1
34 Wood Frm Vented Crawl Space 1	1.3	1.3	1.1
35 Wood Frm Vented Crawl Space 2	1.4	1.4	1.1
36 Wood Frm Vented Crawl Space 3	1.4	1.4	1.1
37 Wood Frm Vented Crawl Space 4	1.4	1.4	1.1
38 Wood Frm Vented Crawl Space 5	1.2	1.3	1.1
39 Wood Frm Vented Crawl Space 6	1.6	1.7	1.4
Average SIR	**1.4**	**1.4**	**1.1**
Max SIR	1.7	1.7	1.6
Min SIR	1.2	1.2	1.0

But only if solar screens unselected
Over double pane wood, just E/W

Other metrics: Wood Frame Vented Crawl Space home, Single pane wood windows		if include 1/3 of air inf savings
Annual cost savings	$152	$187
Measure Cost	$1,386	
Simple Payback	**9.1**	7.4
Energy Savings (Mbtu/yr)		
Initial home heat+cool	45.7	
Storm savings	7.6	
% reduction	**17%**	

Heat pump, central AC with standard Low-E

SIR with different primary window types:

Home type	Single pane wood/vinyl	Double pane metal	Double pane wood/vinyl
1 Exposed Floor 1	1.2	1.1	—
2 Wood Frame Cape Cod 1 KW 1	1.2	1.2	—
3 Wood Frame Cape Cod 2 KW 2	1.2	1.1	—
4 Wood Frame Cape Cod 3 KW 3	1.2	1.2	—
5 Wood Frame Cape Cod 4 KW 4	1.2	1.2	—
6 Wood Frame Cape Cod 1 KW 5	1.3	1.3	—
7 Masonry 1	1.2	1.2	—
8 Masonry 2	1.3	1.3	—
9 Masonry 3	1.5	1.3	—
10 Masonry 4	1.2	1.2	—
11 Masonry 5	1.3	1.3	—
12 Masonry 6	1.6	1.6	1.3
13 Row House Masonry 1	1.2	1.1	—
14 Row House Masonry 2	1.2	1.2	—
15 Row House Wood Frame 1	1.2	1.2	—
16 Row House Wood Frame 2	1.4	1.3	—
17 Semi Detached Masonry 1	1.2	1.2	—
18 Semi Detached Masonry 2	1.3	1.3	—
19 Semi Detached Wood Frame 1	1.1	1.1	—
20 Semi Detached Wood Frame 2	1.3	1.3	—
21 Wood Frm Cond Bsmt 1	1.3	1.3	—
22 Wood Frm Cond Bsmt 2	1.3	1.3	—
23 Wood Frm Cond Bsmt 3	1.4	1.3	—
24 Wood Frm Cond Bsmt 4	1.4	1.4	—
25 Wood Frm Slab 1	1.2	1.2	—
26 Wood Frm Slab 2	1.2	1.2	—
27 Wood Frm Slab 3	1.3	1.2	—
28 Wood Frm Slab 4	1.3	1.3	—
29 Wood Frm Uncon Bsmt 1	1.2	1.2	—
30 Wood Frm Uncon Bsmt 2	1.2	1.2	—
31 Wood Frm Uncon Bsmt 3	1.3	1.2	—
32 Wood Frm Uncon Bsmt 4	1.2	1.2	—
33 Wood Frm Uncon Bsmt 5	1.2	1.2	—
34 Wood Frm Vented Crawl Space 1	1.2	1.2	—
35 Wood Frm Vented Crawl Space 2	1.2	1.2	—
36 Wood Frm Vented Crawl Space 3	1.3	1.2	—
37 Wood Frm Vented Crawl Space 4	1.3	1.3	—
38 Wood Frm Vented Crawl Space 5	1.2	1.2	—
39 Wood Frm Vented Crawl Space 6	1.4	1.4	1.2
Average SIR	**1.3**	**1.2**	—
Max SIR	1.6	1.6	—
Min SIR	1.1	1.1	—

But only if solar screens unselected

Other metrics: Wood Frame Vented Crawl Space home, Single pane wood windows		if include 1/3 of air inf savings
Annual cost savings	$134	$172
Measure Cost	$1,386	
Simple Payback	**10.3**	8.1
Energy Savings (Mbtu/yr)		
Initial home heat+cool	31.9	
Storm savings	4.1	
% reduction	**13%**	

Heat pump, central AC with Solar Control Low-E

SIR with different primary window types:

Home type	Single pane wood/vinyl	Double pane metal	Double pane wood/vinyl
1 Exposed Floor 1	1.4	1.4	1.2
2 Wood Frame Cape Cod 1 KW 1	1.5	1.5	1.2
3 Wood Frame Cape Cod 2 KW 2	1.5	1.5	1.2
4 Wood Frame Cape Cod 3 KW 3	1.5	1.5	1.2
5 Wood Frame Cape Cod 4 KW 4	1.5	1.5	1.2
6 Wood Frame Cape Cod 1 KW 5	1.6	1.5	1.2
7 Masonry 1	1.6	1.6	1.2
8 Masonry 2	1.6	1.8	1.6
9 Masonry 3	1.8	1.8	1.6
10 Masonry 4	1.5	1.5	1.2
11 Masonry 5	1.6	1.6	1.2
12 Masonry 6	1.8	1.8	1.6
13 Row House Masonry 1	1.7	1.4	—
14 Row House Masonry 2	1.7	1.3	—
15 Row House Wood Frame 1	1.6	1.7	1.1
16 Row House Wood Frame 2	1.5	1.5	1.0
17 Semi Detached Masonry 1	1.5	1.5	1.2
18 Semi Detached Masonry 2	1.5	1.4	1.2
19 Semi Detached Wood Frame 1	1.6	1.4	1.2
20 Semi Detached Wood Frame 2	1.6	1.4	1.2
21 Wood Frm Cond Bsmt 1	1.4	1.4	1.2
22 Wood Frm Cond Bsmt 2	1.6	1.6	1.2
23 Wood Frm Cond Bsmt 3	1.6	1.6	1.2
24 Wood Frm Cond Bsmt 4	1.6	1.6	1.2
25 Wood Frm Slab 1	1.4	1.4	1.2
26 Wood Frm Slab 2	1.5	1.5	1.2
27 Wood Frm Slab 3	1.5	1.5	1.2
28 Wood Frm Slab 4	1.5	1.5	1.6
29 Wood Frm Uncon Bsmt 1	1.4	1.4	1.2
30 Wood Frm Uncon Bsmt 2	1.5	1.5	1.2
31 Wood Frm Uncon Bsmt 3	1.5	1.5	1.2
32 Wood Frm Uncon Bsmt 4	1.4	1.4	1.2
33 Wood Frm Uncon Bsmt 5	1.3	1.3	1.2
34 Wood Frm Vented Crawl Space 1	1.4	1.4	1.2
35 Wood Frm Vented Crawl Space 2	1.5	1.5	1.2
36 Wood Frm Vented Crawl Space 3	1.5	1.5	1.2
37 Wood Frm Vented Crawl Space 4	1.5	1.5	1.6
38 Wood Frm Vented Crawl Space 5	1.3	1.3	1.2
39 Wood Frm Vented Crawl Space 6	1.7	1.8	1.5
Average SIR	**1.5**	**1.5**	**1.3**
Max SIR	1.8	1.8	1.6
Min SIR	1.3	1.3	1.0

But only if solar screens unselected
Over double pane wood, just E/W

Other metrics: Wood Frame Vented Crawl Space home, Single pane wood windows		if include 1/3 of air inf savings
Annual cost savings	$164	$202
Measure Cost	$1,386	
Simple Payback	**8.5**	6.9
Energy Savings (Mbtu/yr)		
Initial home heat+cool	31.9	
Storm savings	5.1	
% reduction	**16%**	

Houston TX
Zone 2

HDD65	1371
CDD50	7357
Natural Gas ($/Mcf, 2012 avg)	$10.90
Electricity ($/kWh, 2012 avg)	$0.1104

Low-E Storms $7.85/ft2 + $30/window

NG furnace, central AC with standard Low-E

SIR with different primary window types:

	Home type	Single pane wood/vinyl	Double pane metal	Double pane wood/vinyl
1	Exposed Floor 1	–	–	–
2	Wood Frame Cape Cod 1 KW 1	–	–	–
3	Wood Frame Cape Cod 2 KW 2	–	–	–
4	Wood Frame Cape Cod 3 KW 3	–	–	–
5	Wood Frame Cape Cod 4 KW 4	–	–	–
6	Wood Frame Cape Cod 1 KW 5	–	–	–
7	Masonry 1	–	–	–
8	Masonry 2	–	–	–
9	Masonry 3	–	–	–
10	Masonry 4	–	–	–
11	Masonry 5	–	–	–
12	Masonry 6	–	–	–
13	Row House Masonry 1	–	–	–
14	Row House Masonry 2	–	–	–
15	Row House Wood Frame 1	–	–	–
16	Row House Wood Frame 2	–	–	–
17	Semi Detached Masonry 1	–	–	–
18	Semi Detached Masonry 2	–	–	–
19	Semi Detached Wood Frame 1	–	–	–
20	Semi Detached Wood Frame 2	–	–	–
21	Wood Frm Cond Bsmt 1	–	–	–
22	Wood Frm Cond Bsmt 2	–	–	–
23	Wood Frm Cond Bsmt 3	–	–	–
24	Wood Frm Cond Bsmt 4	–	–	–
25	Wood Frm Slab 1	–	–	–
26	Wood Frm Slab 2	–	–	–
27	Wood Frm Slab 3	–	–	–
28	Wood Frm Slab 4	–	–	–
29	Wood Frm Uncon Bsmt 1	–	–	–
30	Wood Frm Uncon Bsmt 2	–	–	–
31	Wood Frm Uncon Bsmt 3	–	–	–
32	Wood Frm Uncon Bsmt 4	–	–	–
33	Wood Frm Uncon Bsmt 5	–	–	–
34	Wood Frm Vented Crawl Space 1	–	–	–
35	Wood Frm Vented Crawl Space 2	–	–	–
36	Wood Frm Vented Crawl Space 3	–	–	–
37	Wood Frm Vented Crawl Space 4	–	–	–
38	Wood Frm Vented Crawl Space 5	–	–	–
39	Wood Frm Vented Crawl Space 6	–	–	–
	Average SIR	–	–	–
	Max SIR	–	–	–
	Min SIR	–	–	–

NG furnace, central AC with Solar Control Low-E

SIR with different primary window types:

Single pane wood/vinyl	Double pane metal	Double pane wood/vinyl
1.2	1.2	–
1.2	1.2	–
1.2	1.2	–
1.2	1.2	–
1.2	1.2	–
1.2	1.2	–
1.2	1.2	–
1.2	1.7	–
1.7	1.7	–
1.1	1.1	–
1.2	1.2	–
1.2	1.2	–
–	1.0	–
–	1.1	–
1.2	1.2	–
1.1	1.2	–
1.2	1.2	–
1.2	1.2	–
1.2	1.2	–
1.2	1.2	–
1.2	1.2	–
1.2	1.2	–
1.2	1.2	–
1.2	1.2	–
1.2	1.2	–
1.2	1.2	–
1.2	1.2	–
1.7	1.7	–
1.2	1.2	–
1.2	1.2	–
1.2	1.2	–
1.6	1.7	–
1.2	1.2	–
1.2	1.1	–
1.2	1.2	–
1.2	1.2	–
1.1	1.1	–
1.2	1.2	–
1.2	1.1	–
1.2	1.2	–
1.6	1.7	–
1.1	1.1	–
1.5	1.6	1.4
1.2	**1.3**	–
1.7	1.7	–
1.1	1.0	–

But only if solar screens unselected (SIR ~ 2.2)
All only specify east / west, except WFVC5 and 6 have S/E/W
Not sure why jumps from 1.2 to 1.7

Other metrics: Wood Frame Vented Crawl Space home, Single pane wood windows		if include 1/3 of air inf savings
Annual cost savings	$96	$126
Measure Cost	$924	
Simple Payback	**9.6**	7.3
Energy Savings (Mbtu/yr)		
Initial home heat+cool	35.5	
Storm savings	4.5	<-- adjusted for all 4 sides using only 40% of savings on north
% reduction	**13%**	if don't adjust, it is 11%

Heat pump, central AC with standard Low-E

SIR with different primary window types:

Single pane wood/vinyl	Double pane metal	Double pane wood/vinyl
--	--	--
--	--	--
--	--	--

Jacksonville FL
Zone 2

HDD65	1434
CDD50	6847
Natural Gas ($/Mcf, 2012 avg)	--
Electricity ($/kWh, 2012 avg)	$0.1152
Low-e Storms $7.85/ft2 + $30/window	

		Heat pump, central AC with standard Low-e SIR with different primary window types:			**Heat pump, central AC with Solar Control Low-e** SIR with different primary window types:		
	Home type	**Single pane wood/vinyl**	**Double pane metal**	**Double pane wood/vinyl**	**Single pane wood/vinyl**	**Double pane metal**	**Double pane wood/vinyl**
1	Exposed Floor 1	--	--	--	1.2	1.2	--
2	Wood Frame Cape Cod 1 KW 1	--	--	--	1.2	1.2	--
3	Wood Frame Cape Cod 2 KW 2	--	--	--	1.2	1.2	--
4	Wood Frame Cape Cod 3 KW 3	--	--	--	1.2	1.2	--
5	Wood Frame Cape Cod 4 KW 4	--	--	--	1.2	1.2	--
6	Wood Frame Cape Cod 1 KW 5	--	--	--	1.2	1.2	--
7	Masonry 1	--	--	--	1.2	1.2	--
8	Masonry 2	--	--	--	1.2	1.7	--
9	Masonry 3	--	--	--	1.6	1.7	--
10	Masonry 4	--	--	--	1.1	1.1	--
11	Masonry 5	--	--	--	1.2	1.2	--
12	Masonry 6	--	--	--	1.5	1.5	1.4
13	Row House Masonry 1	--	--	--	--	--	--
14	Row House Masonry 2	--	--	--	--	1.1	--
15	Row House Wood Frame 1	--	--	--	1.1	1.1	--
16	Row House Wood Frame 2	--	--	--	1.1	1.1	--
17	Semi Detached Masonry 1	--	--	--	1.2	1.2	--
18	Semi Detached Masonry 2	--	--	--	1.2	1.2	--
19	Semi Detached Wood Frame 1	--	--	--	1.1	1.2	--
20	Semi Detached Wood Frame 2	--	--	--	1.2	1.2	--
21	Wood Frm Cond Bsmt 1	--	--	--	1.2	1.2	--
22	Wood Frm Cond Bsmt 2	--	--	--	1.2	1.2	--
23	Wood Frm Cond Bsmt 3	--	--	--	1.2	1.2	--
24	Wood Frm Cond Bsmt 4	--	--	--	1.6	1.7	--
25	Wood Frm Slab 1	--	--	--	1.2	1.1	--
26	Wood Frm Slab 2	--	--	--	1.2	1.1	--
27	Wood Frm Slab 3	--	--	--	1.2	1.1	--
28	Wood Frm Slab 4	--	--	--	1.6	1.7	--
29	Wood Frm Uncon Bsmt 1	--	--	--	1.2	1.2	--
30	Wood Frm Uncon Bsmt 2	--	--	--	1.2	1.2	--
31	Wood Frm Uncon Bsmt 3	--	--	--	1.2	1.2	--
32	Wood Frm Uncon Bsmt 4	--	--	--	1.2	1.2	--
33	Wood Frm Uncon Bsmt 5	--	--	--	1.1	1.1	--
34	Wood Frm Vented Crawl Space 1	--	--	--	1.2	1.2	--
35	Wood Frm Vented Crawl Space 2	--	--	--	1.2	1.2	--
36	Wood Frm Vented Crawl Space 3	--	--	--	1.2	1.2	--
37	Wood Frm Vented Crawl Space 4	--	--	--	1.6	1.2	--
38	Wood Frm Vented Crawl Space 5	--	--	--	1.1	1.1	--
39	Wood Frm Vented Crawl Space 6	--	--	--	1.5	1.6	1.3
	Average SIR	**--**	**--**	**--**	**1.2**	**1.2**	**--**
	Max SIR	--	--	--	1.6	1.7	--
	Min SIR	--	--	--	1.1	1.1	--

But only if solar screens unselected (SIR ~ 2.3)
Often only specify east / west

Other metrics: Wood Frame Vented Crawl Space home Single pane wood windows		if include 1/3 of air inf savings
Annual cost savings	$96	$120
Measure Cost	$924	
Simple Payback	**9.6**	7.7
Energy Savings (Mbtu/yr)		
Initial home heat+cool	25.8	
Storm savings	3.2	
% reduction	**12%**	

Phoenix AZ
Zone 2

HDD65	1350
CDD50	8425
Natural Gas ($/Mcf, 2012 avg)	--
Electricity ($/kWh, 2012 avg)	$0.1127
Low-e Storms $7.85/ft2 + $30/window	

		Heat pump, central AC with standard Low-e SIR with different primary window types:			Heat pump, central AC with Solar Control Low-e SIR with different primary window types:		
	Home type	**Single pane wood/vinyl**	**Double pane metal**	**Double pane wood/vinyl**	**Single pane wood/vinyl**	**Double pane metal**	**Double pane wood/vinyl**
1	Exposed Floor 1	--	--	--	--	--	--
2	Wood Frame Cape Cod 1 KW 1	--	--	--	--	--	--
3	Wood Frame Cape Cod 2 KW 2	--	--	--	--	--	--
4	Wood Frame Cape Cod 3 KW 3	--	--	--	--	--	--
5	Wood Frame Cape Cod 4 KW 4	--	--	--	--	--	--
6	Wood Frame Cape Cod 1 KW 5	--	--	--	--	--	--
7	Masonry 1	--	--	--	--	--	--
8	Masonry 2	--	--	--	--	--	--
9	Masonry 3	--	--	--	--	--	--
10	Masonry 4	--	--	--	--	--	--
11	Masonry 5	--	--	--	--	--	--
12	Masonry 6	--	--	--	--	--	--
13	Row House Masonry 1	--	--	--	--	--	--
14	Row House Masonry 2	--	--	--	--	--	--
15	Row House Wood Frame 1	--	--	--	--	--	--
16	Row House Wood Frame 2	--	--	--	--	--	--
17	Semi Detached Masonry 1	--	--	--	--	--	--
18	Semi Detached Masonry 2	--	--	--	--	--	--
19	Semi Detached Wood Frame 1	--	--	--	--	--	--
20	Semi Detached Wood Frame 2	--	--	--	--	--	--
21	Wood Frm Cond Bsmt 1	--	--	--	--	--	--
22	Wood Frm Cond Bsmt 2	--	--	--	--	--	--
23	Wood Frm Cond Bsmt 3	--	--	--	--	--	--
24	Wood Frm Cond Bsmt 4	--	--	--	--	--	--
25	Wood Frm Slab 1	--	--	--	--	--	--
26	Wood Frm Slab 2	--	--	--	--	--	--
27	Wood Frm Slab 3	--	--	--	--	--	--
28	Wood Frm Slab 4	--	--	--	--	--	--
29	Wood Frm Uncon Bsmt 1	--	--	--	--	--	--
30	Wood Frm Uncon Bsmt 2	--	--	--	--	--	--
31	Wood Frm Uncon Bsmt 3	--	--	--	--	--	--
32	Wood Frm Uncon Bsmt 4	--	--	--	--	--	--
33	Wood Frm Uncon Bsmt 5	--	--	--	--	--	--
34	Wood Frm Vented Crawl Space 1	--	--	--	--	--	--
35	Wood Frm Vented Crawl Space 2	--	--	--	--	--	--
36	Wood Frm Vented Crawl Space 3	--	--	--	--	--	--
37	Wood Frm Vented Crawl Space 4	--	--	--	--	--	--
38	Wood Frm Vented Crawl Space 5	--	--	--	--	--	--
39	Wood Frm Vented Crawl Space 6	--	--	--	--	--	--
	Average SIR	--	--	--	--	--	--
	Max SIR	--	--	--	--	--	--
	Min SIR	--	--	--	--	--	--
		None had SIR > 1			None had SIR > 1		

Miami FL
Zone 1

HDD65	200
CDD50	9474
Natural Gas ($/Mcf, 2012 avg)	--
Electricity ($/kWh, 2012 avg)	$0.1152
Low-e Storms $7.85/ft2 + $30/window	

		Heat pump, central AC with standard Low-e SIR with different primary window types:			**Heat pump, central AC with Solar Control Low-e** SIR with different primary window types:		
	Home type	**Single pane wood/vinyl**	**Double pane metal**	**Double pane wood/vinyl**	**Single pane wood/vinyl**	**Double pane metal**	**Double pane wood/vinyl**
1	Exposed Floor 1	--	--	--	1.2	1.2	1.1
2	Wood Frame Cape Cod 1 KW 1	--	--	--	1.2	1.2	1.1
3	Wood Frame Cape Cod 2 KW 2	--	--	--	1.2	1.2	1.1
4	Wood Frame Cape Cod 3 KW 3	--	--	--	1.2	1.2	1.1
5	Wood Frame Cape Cod 4 KW 4	--	--	--	1.2	1.2	1.1
6	Wood Frame Cape Cod 1 KW 5	--	--	--	1.2	1.2	1.1
7	Masonry 1	--	--	--	1.2	1.3	1.1
8	Masonry 2	--	--	--	1.2	1.3	1.1
9	Masonry 3	--	--	--	1.2	1.3	1.1
10	Masonry 4	--	--	--	1.2	1.3	1.1
11	Masonry 5	--	--	--	1.2	1.2	1.1
12	Masonry 6	--	--	--	1.2	1.2	1.1
13	Row House Masonry 1	--	--	--	1.2	1.3	1.1
14	Row House Masonry 2	--	--	--	1.2	1.4	1.1
15	Row House Wood Frame 1	--	--	--	1.2	1.3	1.1
16	Row House Wood Frame 2	--	--	--	1.2	1.2	1.1
17	Semi Detached Masonry 1	--	--	--	1.2	1.3	1.1
18	Semi Detached Masonry 2	--	--	--	1.2	1.2	1.1
19	Semi Detached Wood Frame 1	--	--	--	1.2	1.2	1.1
20	Semi Detached Wood Frame 2	--	--	--	1.2	1.2	1.1
21	Wood Frm Cond Bsmt 1	--	--	--	1.2	1.2	1.1
22	Wood Frm Cond Bsmt 2	--	--	--	1.2	1.2	1.1
23	Wood Frm Cond Bsmt 3	--	--	--	1.2	1.2	1.1
24	Wood Frm Cond Bsmt 4	--	--	--	1.2	1.2	1.1
25	Wood Frm Slab 1	--	--	--	1.2	1.2	1.1
26	Wood Frm Slab 2	--	--	--	1.2	1.2	1.1
27	Wood Frm Slab 3	--	--	--	1.2	1.2	1.1
28	Wood Frm Slab 4	--	--	--	1.2	1.2	1.1
29	Wood Frm Uncon Bsmt 1	--	--	--	1.2	1.2	1.1
30	Wood Frm Uncon Bsmt 2	--	--	--	1.2	1.2	1.1
31	Wood Frm Uncon Bsmt 3	--	--	--	1.2	1.2	1.1
32	Wood Frm Uncon Bsmt 4	--	--	--	1.2	1.2	1.1
33	Wood Frm Uncon Bsmt 5	--	--	--	1.2	1.2	1.1
34	Wood Frm Vented Crawl Space 1	--	--	--	1.2	1.2	1.1
35	Wood Frm Vented Crawl Space 2	--	--	--	1.2	1.2	1.1
36	Wood Frm Vented Crawl Space 3	--	--	--	1.2	1.2	1.1
37	Wood Frm Vented Crawl Space 4	--	--	--	1.2	1.2	1.1
38	Wood Frm Vented Crawl Space 5	--	--	--	1.2	1.2	1.1
39	Wood Frm Vented Crawl Space 6	--	--	--	1.5	1.9	1.1
	Average SIR	**--**	**--**	**--**	**1.2**	**1.2**	**1.1**
	Max SIR	--	--	--	1.5	1.9	1.1
	Min SIR	--	--	--	1.2	1.2	1.1

But only if solar screens and film unselected
All specify south / east / west

Other metrics: Wood Frame Vented Crawl Space home Single pane wood windows		if include 1/3 of air inf savings
Annual cost savings	$95	$132
Measure Cost	$924	
Simple Payback	**9.7**	7.0
Energy Savings (Mbtu/yr)		
Initial home heat+cool	33.0	
Storm savings	3.2	
% reduction	**10%**	

Appendix B

RESFEN 6 Modeling Assumptions

The following table captures the differences in modeling assumptions for the Energy Star analysis reference house between RESFEN 5 and RESFEN 6 (in development).

Table 0-1. RESFEN 6 Assumptions – Reference House for Energy Star Analysis

PARAMETER	RESFEN 5	RESFEN 6 - DRAFT	Notes on changes
Floor Area (ft^2 & dimensions)	Reference House: 2000 sf Specific House: Variable, from 1,000 to 4,000 square feet, input by user.	Reference House: New – 1 Story: 1700sf New – 2 Story: 2800sf Existing 1 Story: 1700sf Existing 2 Story: 2600sf	NFRC noted the following: New Construction: 2005 U.S. Census Bureau Characteristics Median New house size is 2200sf; Average is 2400. Existing Construction: Keep same default as RESFEN 5 unless new data to the contrary is presented. LBNL decided to keep with these basic numbers, but differentiate between smaller single story homes and larger two story homes. [For the Energy Star analysis, results for both 1 and 2 story homes will be generated. End results will be based on appropriate regional weightings of 1 and 2 story homes.] Using RECS 2001, an analysis of public use microdata, we came up with the following, at a national level: - For existing homes (defined as pre-1990), RECS supports an average house size of 2000 sf, as NFRC had agreed upon. Single story homes (65% of existing homes nationally) are 1700sf and Two+ story homes (35%) are 2600sf. When weighted by fractions of the population, the average comes out to 2000. - For New (after 1990) homes, NFRC had chosen to go with the census data Median of 2200, not the average of 2400. We agree that it makes sense to use a Median so that the size is not skewed by the small number of very large houses. RECS comes up with a slightly different average of 2600 (2000sf for single and 3400 Sf for 2+ story). We decided we should keep the NFRC value of 2200 as the normalized area but use RECS data on 1 and 2 story to modify this average number. This leads to using 1700 sf for New - 1 story (58%) and 2800 sf for New 2-story (42%).

House Type	New Construction Existing Construction	Reference House: New Construction is frame. Existing Construction is frame. Both 1 and 2 story houses are modeled in all climates. National or regional energy impact studies will be based on the fractions of 1 and 2 story homes in each climate, for New and Existing.	For reference, see census map: http://www.eia.doe.gov/emeu/recs/census_map.htm l IECC Climate map at: www.energycodes.gov/implement/pdfs/color_**map_ climate_zone**s_Mar03.pdf Data on New Construction; From http://www.census.gov/const/www/charindex.html #singlecomplete Look at Number of Stories Data on Existing Construction Source: RECS 2001 Microdata, http://www.eia.doe.gov/emeu/recs/recs2001/publicu se2001.html
Foundation	Foundation is based on location based on NAHB data. There are a maximum of three options per climate zone, chosen from: Basement Slab-on-Grade Crawlspace	Default foundation based on location as with RESFEN 5.	What is in RESFEN is very similar to NFRC. NFRC proposed: New and Existing Construction: Basement in climate zone 5-8; Crawlspace in climate zone 4; Slab-on-grade in climate zones 1-3. What is in RESFEN is essentially this, except that some southern Zone 4 cities have slabs and some northern Zone 4 cities have basements to better represent current practice. Foundation modeling process updated based on 1998 research: Winkelmann, FC. 1998. ″Underground Surfaces: How to Get a Better Underground Surface Heat Transfer Calculation in DOE-2.1E″, Building Energy Simulation Users′ News, Vol. 19, No. 1 (Spring 1998), pp. 6-12, Lawrence Berkeley National Laboratory, Berkeley CA, Electronic versions of the Users′ News are available at http://gundog.lbl.gov.

Insulation [(a)]	Envelope insulation levels are based on location. See RESFEN 5 documentation, Table 6-1 for a list of Packages that correspond to each location. See Tables 6-3 and 6-4 for a list of R-values for each building component for each location. See Table 6-_ for a list of U-factors that correspond to the R-value constructions. **New construction:** See Table 6-4. (Council of American Building Officials, 1993) **Existing construction:** See Table 6-5. (Ritschard, et al. 1992)	New Construction: Envelope insulation levels based on location using 2006 IECC requirements in Table 402.1.1 (except for fenestration). Existing: Same as RESFEN 5.0.	
Infiltration	**New Construction:** ELA=0.77 ft^2 (0.58 ACH) **Existing Construction:** ELA=1.00 ft^2 (0.70 ACH)	New Construction: SLA = 0.00036 Existing Construction: SLA = 0.00054	As proposed by NFRC. Consistent with 2006 IECC reference home Table 404.5.2(1). SLA is EA/total sf. [Note: inconsistency between RESFEN 3.1/5.0 documentation and code; infiltration in code was set to SLA=.00057.]

Structural Mass (lb/ft^2)	This is a parameter used in programs that don't explicitly model internal walls. In RESFEN, we use a simple equation to estimate the amount of internal walls per floor area: interior wall area = 0.527 * floor area RESFEN then models the amount of internal walls. Since interior walls are typically 2x4 16″ oc with 0.5″ of gypboard on each side, the amount of material per square foot of wall is • 1″ x 12″ x 12″ or 0.08333 ft3 of gypboard • 3.5″ x 1.625″ x 12″ /16 or 0.002469 ft3 of wood The total weight per floor area of floor adds up to 2.24 lbs/ft2, which is somewhat lower than the the 3.5 lb/ft2 cited. But in a 2- story, there's also the floor that would add another 2.20 lbs/ft2, for a total of 4.44 lbs/ft2. This is consistent with the average value of 3.5 lb/ft2 in the IECC. Basement walls and slabs are modeled separately.	Internal walls are modeled explicitly as with RESFEN 5. Where masonry floors are used: 80% of floor area covered by R-2 carpet and pad, and 20% of floor directly exposed to room air. This is in addition to the 3.5 lb/ft2/ Basement walls: masonry, and include insulation located on the exterior of the walls (new construction) and the interior side of the walls (existing construction). This is in addition to above.	Consistent with 2006 IECC reference home Table 404.5.2(1) average value.
Internal Mass Furniture (lb/ft^2)	8.0 lb/ft^2 of floor area, in accordance with the Model Energy Code and NFRC Annual Energy Performance Subcommittee recommendation (September 1998).	8.0 lb/ft^2 of floor area	Consistent with 2006 IECC reference home Table 404.5.2(1).

Solar Gain Reduction	**Options:** **None:** No solar gain reduction **Overhang:** 2' Exterior Overhangs **Obstruction:** Exterior Obstructions, a completely opaque (□=0.0), same-height obstruction 20 feet away, intended to represent adjacent buildings. **Interior:** Interior shades with a Seasonal SHGC multiplier, summer value = 0.80, winter value = 0.90. **Int+Ovh:** Interior shades & 2′ overhangs **Ovh+Obs:** 2′ overhangs & obstructions **All:** Interior shades, 2′ overhangs, & obstructions **Typical**[(b)]**:** to represent a statistically average solar gain reduction for a generic house, this option includes: Interior shades (Seasonal SHGC multiplier, summer value = 0.80, winter value = 0.90); 1′ overhang; a 67% transmitting same- height obstruction 20′ away intended to represent adjacent buildings. To account for other sources of solar heat gain reduction (insect screens, trees, dirt, building & window self- shading), the SHGC multiplier was further reduced by 0.1. This results in a final winter SHGC multiplier of 0.8 and a final summer SHGC multiplier of 0.7. (Note these factors are multipliers; i.e. a window with a SHGC of 0.5 is reduced to 0.4 in the winter and 0.35 in the summer.)	**Same as RESFEN 5.** **Reference House uses Typical.**	RESFEN assumptions of typical should be maintained unless there is valid data to the contrary; otherwise impacts of windows are overstated
Window Area (% Floor Area)	Variable	Specific House: Variable Reference House: 15%	18% is too high. A recent DOE/PNNL study from a few years ago found 13.5% to be average. IECC implies that below 12% is low and above 18% is high….which implies 15% (as used in RESFEN) is appropriate.
Window Type	Variable	Variable	

Window Distribution	Variable	Specific House: Variable Reference House: Evenly Distributed on All four orientations.	
HVAC System	Furnace & A/C, Heat Pump	Gas furnace & A/C. Heat Pump with A/C in South and SW	There are a significant number of Heat Pumps in the South (half of new construction in the south) and some in the West (presumably the SW). From http://www.census.gov/const/www/charindex.html #singlecomplete Look at Type of Heating Fuel; Data on Existing Construction There is also Oil Heating in the NorthEast (49% in New England and 24% in Mid-Atlantic) in Existing Homes. Rather than model Oil homes in the NE region in Existing houses; or we can account for this later in the speadsheet part of this project. (Not much in New Construction.)
HVAC System Sizing	For each climate, system sizes are fixed for all window options. Fixed sizes are based on the use of DOE-2 auto-sizing for the same house as defined in the analysis, with the most representative window for that specific climate. An auto-sizing multiplier of 1.3 used to account for a typical safety factor. (e)	Same as RESFEN 5 for Existing homes. Autosizing is used for New homes – they are sized with the specific windows chosen.	Consistent with 2006 IECC reference home Table 404.5.2(1). Section M1401.3 of the International Residential Code says " Heating and cooling equipment shall be sized based on building loads calculated in accordance with ACCA Manual J or other approved heating and cooling calculation methodologies."

HVAC Efficiency	**New Construction:** AFUE = 0.78, A/C SEER=10.0 **Existing Construction:** AFUE = 0.70, A/C SEER= 8.0	**New:** Gas furnace: AFUE = 0.80 in climate zones 1-3, 0.90 in climate zones 4-8. A/C SEER = 13. Heat pump HSPF = 7.7; Oil furnace AFUE = 0.80 **Existing**: Gas furnace AFUE = 0.78; A/C (& Heat Pump) SEER = 10; Heat pump HSPF = 6.8	**For New, as per NFRC:** Gas furnace: 2005 Gas Appliance Manufacturers Association data showed 34% of all U.S. furnaces sold are condensing (AFUE 90+%). We assume most of these are used in the north, so use new federal minimum (0.80) in zones 1-3, and condensing furnace (0.90) in zones 4-8. A/C: New federal minimum. Heat pump: New federal minimum. Conversion from SEER or HPSF to COP (1/CEIR) for use in DOE2 using updated research: http://www.fsec.ucf.edu/en/publications/html/FSEC-PF-413-04/
Duct Losses	Heating: 10% (fixed) Cooling: 10% (fixed)	12% for basement foundation 20% for crawlspace and slab-on-grade foundations	Consistent with 2006 IECC proposed design default distribution efficiencies (Table 404.5.2(2). As proposed by NFRC. Duct losses entered into DOE2 by modifying efficiencies.
Part-Load Performance	New part-load curves for DOE2 (Henderson 1998) for both new and existing house types	Same as RESFEN 5.	
Thermostat Settings	Heating: 70°F, Cooling: 78°F Basement (partially conditioned): Heating 62°F, Cooling 85°F	Heating: 70°F, Cooling: 78°F Basement (partially conditioned): Heating 62°F, Cooling 85°F	
Night Heating Setback	65°F (11 PM – 6 AM[d])	65°F (11 PM – 6 AM)	
Cooling Setup	N/A	N/A	

Internal Loads	Sensible: 43,033 Btu/day + (floor area * 8.42 Btu/ft^2-day for lighting) Latent: 12.2 kBtu/day	Use IECC [Table 404.5.2(1)] proposal of: Internal gain (Btu/day) = 17,900 + 23.8×floor area + 4104×number of bedrooms. 3 bedrooms shall be used.	This includes latent as well as sensible, as well as lighting loads (per conversation with Phil Fairey, 1/11/08). The way FSEC uses the equation is for the total internal loads of the house. They then subtract out the people heat gain, which they model as per standard DOE-2/ASHRAE assumption (255 sensible/200 latent per person per hour, etc.). The remainder is then assumed to be 0.80 sensible and 0.20 latent. The hourly profile is based on modeling assumptions developed by the California Energy Commission in 1980 (Mickey Horn and Cynthia Helmich 1980. ″Assumptions Used with Energy Performance Computer Programs″, Project Report No. 7 for ″1980 Residential Building Standard Development Project″, June 1980, P400-80-026, pp. 33-48).
Natural Ventilation	Enthalpic – Sherman-Grimsrud (78°F / 72°F based on 4 days′ history[e]) Windows closed from 11pm to 6am. Only 25% of window area can be open for ventilation. Windows will only open if outdoor temperature has been below the setpoint for prior 4 days.	Maximum operable window area reduced from 25% to 12.5%. Max ACH capped at 10. Based on California research on use of windows for ventilation.	RESFEN 6 algorithm updated based on the reported operation of windows in the recent Sherman and Price report, "Study of Ventilation Practices and Household Characteristics in New California Homes:" http://www.arb.ca.gov/research/apr/past/03-326.pdf
Weather Data	All TMY2[f]		
Number of Locations	239 US cities[f] 4 Canadian cities	For E* analysis: 97 EWC climates plus Charlotte NC, Amarillo TX, and Prescott AZ	
Calculation Tool	DOE-2.1E	DOE 2.1E version 1.14	

Footnotes

(a) Insulation values do not include exterior siding, structural sheathing, and interior drywall. For examples, an R-19 requirement could be met EITHER by R-19 cavity insulation OR R-13 cavity insulation plus R-6 insulating sheathing. Wall requirements apply to wood-frame or mass (concrete, masonry, log) wall constructions, but do not apply to metal-frame construction.″

(b) These assumptions are intended to represent the average solar heat gain reduction for a large sample of houses. A one-foot overhang is assumed on all four orientations in order to represent the average of a two-foot overhang and no overhang. A 67% transmitting obstruction 20 feet away on all four orientations represents the average of obstructions (such as neighboring buildings and trees) 20 feet away on one-third of the total windows and no obstructions in front of the remaining two-thirds of windows. An interior shade is assumed to have a Solar Heat Gain Coefficient multiplier of 0.9 during the winter and 0.8 during the summer. To account for solar heat gain reducing effects from other sources such as screens, trees, dirt, and self-shading of the building, the SHGC multiplier was further reduced by 0.1 throughout the year. This amounts to a 12.5% decrease in the summer and an 11.1% decrease in the winter. The final SHGC multipliers (0.8 in the winter and 0.7 in the summer) thus reflect the combined effects of shading devices and other sources.

(c) RESFEN 5: For each climate, DOE-2′s auto-sizing feature was used with the window most likely to be installed in new construction (assumed to be the MEC default). Tables 6.4 and 6.5 show the required prescriptive U-factors for windows for the 52 climates. For climates where the U-factor requirement is greater than or equal to 1.0, an aluminum frame window with single glazing (U-factor = 1.30; SHGC = 0.74) is used. For climates where the U-factor requirement is between 0.65 and 1.0, an aluminum frame window with double glazing (U-factor = 0.87; SHGC = 0.66) is used. For climates where the U-factor requirements are below 0.65, as well as in the four Canadian climates, a vinyl frame window with double glazing (U-factor = 0.49; SHGC = 0.57) is used for the sizing calculation.

(d) RESFEN models a moderate setback of 65° F in recognition that some but not all houses may use night setbacks. Recent studies of residential indoor conditions have shown that, during the heating season, nighttime temperatures are significantly lower than daytime temperatures (Ref: "Occupancy Patterns and Energy Consumption in New California Houses," Berkeley Solar Group for the California Energy Commission, 1990).

(e) RESFEN uses a feature in DOE-2 that allows the ventilation temperature to switch between a higher heating (or winter) and a lower cooling (or summer) temperature based on the cooling load over the previous four days.

(f) RESFEN uses Typical Meteorologcal Year (TMY2) weather tapes from the National Renewable Energy Laboratory. There are 239 TMY2 locations with average weather data compiled from 30+ years of historical weather data. (National Renewable Energy Laboratory, 1995).

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Appendix C

RESFEN Calculation Results

Smaller, Older Home (1-story, 1700 ft^2)

Climate Zone	Location	Window	HVAC	Whole House Cooling		Whole House Heating		Source Energy		% source energy savings
8	AK Fairbanks	Wood frame, single pane	Furnace / AC	72	kWh	354.1	MBtu	387.5	MBtu	--
8	AK Fairbanks	with exterior clear panel	Furnace / AC	59	kWh	301	MBtu	329.4	MBtu	15.0%
8	AK Fairbanks	with interior clear panel	Furnace / AC	59	kWh	297.8	MBtu	325.9	MBtu	15.9%
8	AK Fairbanks	with exterior low-e panel	Furnace / AC	45	kWh	289.7	MBtu	316.9	MBtu	**18.2%**
8	AK Fairbanks	with interior low-e panel	Furnace / AC	56	kWh	283.5	MBtu	310.2	MBtu	**19.9%**
8	AK Fairbanks	Wood frame, double pane	Furnace / AC	66	kWh	313.5	MBtu	343.1	MBtu	--
8	AK Fairbanks	with exterior clear panel	Furnace / AC	53	kWh	297.6	MBtu	325.6	MBtu	5.1%
8	AK Fairbanks	with interior clear panel	Furnace / AC	58	kWh	294.2	MBtu	321.9	MBtu	6.2%
8	AK Fairbanks	with exterior low-e panel	Furnace / AC	40	kWh	288.6	MBtu	315.6	MBtu	**8.0%**
8	AK Fairbanks	with interior low-e panel	Furnace / AC	52	kWh	283.8	MBtu	310.5	MBtu	**9.5%**
8	AK Fairbanks	Metal frame, double pane	Furnace / AC	58	kWh	332.3	MBtu	363.5	MBtu	--
8	AK Fairbanks	with exterior clear panel	Furnace / AC	57	kWh	305.5	MBtu	334.3	MBtu	8.1%
8	AK Fairbanks	with interior clear panel	Furnace / AC	55	kWh	301.9	MBtu	330.3	MBtu	9.1%
8	AK Fairbanks	with exterior low-e panel	Furnace / AC	44	kWh	293.3	MBtu	320.8	MBtu	**11.8%**
8	AK Fairbanks	with interior low-e panel	Furnace / AC	49	kWh	289.4	MBtu	316.6	MBtu	**12.9%**
8	AK Fairbanks	with exterior clear panel, worst case mounting	Furnace / AC	52	kWh	314.8	MBtu	344.4	MBtu	5.3%
8	AK Fairbanks	with exterior low-e panel, worst case mounting	Furnace / AC	39	kWh	307.5	MBtu	336.2	MBtu	7.5%
7	AK Anchorage	Wood frame, single pane	Furnace / AC	12	kWh	213.8	MBtu	233.6	MBtu	--
7	AK Anchorage	with exterior clear panel	Furnace / AC	10	kWh	173.9	MBtu	190.0	MBtu	18.7%
7	AK Anchorage	with interior clear panel	Furnace / AC	10	kWh	171.6	MBtu	187.5	MBtu	19.7%
7	AK Anchorage	with exterior low-e panel	Furnace / AC	7	kWh	165	MBtu	180.3	MBtu	**22.8%**
7	AK Anchorage	with interior low-e panel	Furnace / AC	9	kWh	160.2	MBtu	175.0	MBtu	**25.1%**
7	AK Anchorage	Wood frame, double pane	Furnace / AC	11	kWh	183.1	MBtu	200.1	MBtu	--
7	AK Anchorage	with exterior clear panel	Furnace / AC	9	kWh	171.6	MBtu	187.5	MBtu	6.3%
7	AK Anchorage	with interior clear panel	Furnace / AC	9	kWh	169.1	MBtu	184.8	MBtu	7.7%
7	AK Anchorage	with exterior low-e panel	Furnace / AC	7	kWh	164.3	MBtu	179.5	MBtu	**10.3%**
7	AK Anchorage	with interior low-e panel	Furnace / AC	9	kWh	160.6	MBtu	175.5	MBtu	**12.3%**
7	AK Anchorage	Metal frame, double pane	Furnace / AC	9	kWh	198.2	MBtu	216.5	MBtu	--
7	AK Anchorage	with exterior clear panel	Furnace / AC	9	kWh	177.8	MBtu	194.3	MBtu	10.3%
7	AK Anchorage	with interior clear panel	Furnace / AC	9	kWh	175.1	MBtu	191.3	MBtu	11.6%
7	AK Anchorage	with exterior low-e panel	Furnace / AC	7	kWh	167.9	MBtu	183.4	MBtu	**15.3%**
7	AK Anchorage	with interior low-e panel	Furnace / AC	8	kWh	164.9	MBtu	180.2	MBtu	**16.8%**
7	AK Anchorage	with exterior clear panel, worst case mounting	Furnace / AC	9	kWh	185.2	MBtu	202.3	MBtu	6.6%
7	AK Anchorage	with exterior low-e panel, worst case mounting	Furnace / AC	6	kWh	179.1	MBtu	195.6	MBtu	9.6%

Climate Zone	Location	Window	Cooling Cost ($)	Heating Cost ($)	Total Cost ($)	Energy cost savings	% energy cost savings	Simple payback	Payback for low-e
8	AK Fairbanks	Wood frame, single pane	12.82	2931.54	2944.36	--	--	--	
8	AK Fairbanks	with exterior clear panel	10.5	2492.42	2502.92	$441.44	15.0%	5.1	
8	AK Fairbanks	with interior clear panel	10.5	2466.05	2476.55	$467.81	15.9%	4.8	
8	AK Fairbanks	with exterior low-e panel	8.01	2398.98	2406.99	$537.37	**18.3%**	**4.7**	**2.7**
8	AK Fairbanks	with interior low-e panel	9.97	2347.55	2357.52	$586.84	**19.9%**	**4.3**	**2.1**
8	AK Fairbanks	Wood frame, double pane	11.75	2595.71	2607.46	--	--	--	
8	AK Fairbanks	with exterior clear panel	9.43	2463.88	2473.31	$134.15	5.1%	16.8	
8	AK Fairbanks	with interior clear panel	10.32	2435.63	2445.95	$161.51	6.2%	14.0	
8	AK Fairbanks	with exterior low-e panel	7.12	2389.53	2396.65	$210.81	**8.1%**	**11.9**	**3.3**
8	AK Fairbanks	with interior low-e panel	9.26	2350.01	2359.27	$248.19	**9.5%**	**10.1**	**2.9**
8	AK Fairbanks	Metal frame, double pane	10.32	2751.44	2761.76	--	--	--	
8	AK Fairbanks	with exterior clear panel	10.15	2529.77	2539.92	$221.84	8.0%	10.2	
8	AK Fairbanks	with interior clear panel	9.79	2499.72	2509.51	$252.25	9.1%	8.9	
8	AK Fairbanks	with exterior low-e panel	7.83	2428.57	2436.4	$325.36	**11.8%**	**7.7**	**2.5**
8	AK Fairbanks	with interior low-e panel	8.72	2396.13	2404.85	$356.91	**12.9%**	**7.0**	**2.4**
8	AK Fairbanks	with exterior clear panel, worst case mounting	9.26	2606.39	2615.65	$146.11	5.3%	15.4	
8	AK Fairbanks	with exterior low-e panel, worst case mounting	6.94	2546.04	2552.98	$208.78	7.6%	12.0	
7	AK Anchorage	Wood frame, single pane	2.14	1770.6	1772.74	--	--	--	
7	AK Anchorage	with exterior clear panel	1.78	1439.88	1441.66	$331.08	18.7%	6.8	
7	AK Anchorage	with interior clear panel	1.78	1420.92	1422.7	$350.04	19.7%	6.4	
7	AK Anchorage	with exterior low-e panel	1.25	1365.89	1367.14	$405.60	**22.9%**	**6.2**	**3.4**
7	AK Anchorage	with interior low-e panel	1.6	1326.62	1328.22	$444.52	**25.1%**	**5.7**	**2.7**
7	AK Anchorage	Wood frame, double pane	1.96	1516.05	1518.01	--	--	--	
7	AK Anchorage	with exterior clear panel	1.6	1421.05	1422.65	$95.36	6.3%	23.7	
7	AK Anchorage	with interior clear panel	1.6	1400.41	1402.01	$116.00	7.6%	19.5	
7	AK Anchorage	with exterior low-e panel	1.25	1360.11	1361.36	$156.65	**10.3%**	**16.0**	**4.2**
7	AK Anchorage	with interior low-e panel	1.6	1329.73	1331.33	$186.68	**12.3%**	**13.5**	**3.6**
7	AK Anchorage	Metal frame, double pane	1.6	1640.8	1642.4	--	--	--	
7	AK Anchorage	with exterior clear panel	1.6	1472.51	1474.11	$168.29	10.2%	13.4	
7	AK Anchorage	with interior clear panel	1.6	1449.75	1451.35	$191.05	11.6%	11.8	
7	AK Anchorage	with exterior low-e panel	1.25	1390.32	1391.57	$250.83	**15.3%**	**10.0**	**3.1**
7	AK Anchorage	with interior low-e panel	1.42	1365.31	1366.73	$275.67	**16.8%**	**9.1**	**3.0**
7	AK Anchorage	with exterior clear panel, worst case mounting	1.6	1533.12	1534.72	$107.68	6.6%	21.0	
7	AK Anchorage	with exterior low-e panel, worst case mounting	1.07	1482.79	1483.86	$158.54	9.7%	15.8	

Climate Zone	Location	Window	HVAC	Whole House Cooling		Whole House Heating		Source Energy		% source energy savings
7	MN Duluth	Wood frame, single pane	Furnace / AC	194	kWh	220.6	MBtu	243.1	MBtu	--
7	MN Duluth	with exterior clear panel	Furnace / AC	161	kWh	176	MBtu	194.0	MBtu	20.2%
7	MN Duluth	with interior clear panel	Furnace / AC	167	kWh	173.5	MBtu	191.4	MBtu	21.3%
7	MN Duluth	with exterior low-e panel	Furnace / AC	137	kWh	167.3	MBtu	184.3	MBtu	**24.2%**
7	MN Duluth	with interior low-e panel	Furnace / AC	159	kWh	162	MBtu	178.7	MBtu	**26.5%**
7	MN Duluth	Wood frame, double pane	Furnace / AC	181	kWh	185.9	MBtu	205.1	MBtu	--
7	MN Duluth	with exterior clear panel	Furnace / AC	147	kWh	173.7	MBtu	191.4	MBtu	6.7%
7	MN Duluth	with interior clear panel	Furnace / AC	157	kWh	170.9	MBtu	188.4	MBtu	8.1%
7	MN Duluth	with exterior low-e panel	Furnace / AC	128	kWh	166.8	MBtu	183.6	MBtu	**10.5%**
7	MN Duluth	with interior low-e panel	Furnace / AC	147	kWh	162.5	MBtu	179.1	MBtu	**12.7%**
7	MN Duluth	Metal frame, double pane	Furnace / AC	159	kWh	202.1	MBtu	222.5	MBtu	--
7	MN Duluth	with exterior clear panel	Furnace / AC	154	kWh	180.1	MBtu	198.4	MBtu	10.8%
7	MN Duluth	with interior clear panel	Furnace / AC	150	kWh	177.1	MBtu	195.1	MBtu	12.3%
7	MN Duluth	with exterior low-e panel	Furnace / AC	138	kWh	170.5	MBtu	187.8	MBtu	**15.6%**
7	MN Duluth	with interior low-e panel	Furnace / AC	143	kWh	167	MBtu	184.0	MBtu	**17.3%**
7	MN Duluth	with exterior clear panel, worst case mounting	Furnace / AC	147	kWh	188	MBtu	207.0	MBtu	7.0%
7	MN Duluth	with exterior low-e panel, worst case mounting	Furnace / AC	124	kWh	182.3	MBtu	200.5	MBtu	9.9%
6	MN Minneapolis	Wood frame, single pane	Furnace / AC	800	kWh	163.3	MBtu	187.5	MBtu	--
6	MN Minneapolis	with exterior clear panel	Furnace / AC	691	kWh	128.3	MBtu	148.0	MBtu	21.1%
6	MN Minneapolis	with interior clear panel	Furnace / AC	690	kWh	126.4	MBtu	146.0	MBtu	22.2%
6	MN Minneapolis	with exterior low-e panel	Furnace / AC	619	kWh	121.5	MBtu	139.8	MBtu	**25.5%**
6	MN Minneapolis	with interior low-e panel	Furnace / AC	671	kWh	117.4	MBtu	135.9	MBtu	**27.5%**
6	MN Minneapolis	Wood frame, double pane	Furnace / AC	739	kWh	136.1	MBtu	157.1	MBtu	--
6	MN Minneapolis	with exterior clear panel	Furnace / AC	658	kWh	126.5	MBtu	145.7	MBtu	7.3%
6	MN Minneapolis	with interior clear panel	Furnace / AC	679	kWh	124.3	MBtu	143.5	MBtu	8.6%
6	MN Minneapolis	with exterior low-e panel	Furnace / AC	590	kWh	121.1	MBtu	139.0	MBtu	**11.5%**
6	MN Minneapolis	with interior low-e panel	Furnace / AC	648	kWh	117.7	MBtu	136.0	MBtu	**13.5%**
6	MN Minneapolis	Metal frame, double pane	Furnace / AC	700	kWh	148.7	MBtu	170.4	MBtu	--
6	MN Minneapolis	with exterior clear panel	Furnace / AC	682	kWh	131.5	MBtu	151.4	MBtu	11.1%
6	MN Minneapolis	with interior clear panel	Furnace / AC	669	kWh	129.2	MBtu	148.8	MBtu	12.7%
6	MN Minneapolis	with exterior low-e panel	Furnace / AC	610	kWh	124	MBtu	142.4	MBtu	**16.4%**
6	MN Minneapolis	with interior low-e panel	Furnace / AC	635	kWh	121.2	MBtu	139.6	MBtu	**18.1%**
6	MN Minneapolis	with exterior clear panel, worst case mounting	Furnace / AC	656	kWh	137.6	MBtu	157.8	MBtu	7.4%
6	MN Minneapolis	with exterior low-e panel, worst case mounting	Furnace / AC	583	kWh	133.2	MBtu	152.1	MBtu	10.7%

Climate Zone	Location	Window	Cooling Cost ($)	Heating Cost ($)	Total Cost ($)	Energy cost savings	% energy cost savings	Simple payback	Payback for low-e
7	MN Duluth	Wood frame, single pane	22.06	1718.71	1740.77	--	--	--	
7	MN Duluth	with exterior clear panel	18.31	1370.78	1389.09	$351.68	20.2%	6.4	
7	MN Duluth	with interior clear panel	19.04	1351.27	1370.31	$370.46	21.3%	6.1	
7	MN Duluth	with exterior low-e panel	15.62	1303.44	1319.06	$421.71	**24.2%**	**6.0**	**3.6**
7	MN Duluth	with interior low-e panel	18.13	1261.89	1280.02	$460.75	**26.5%**	**5.5**	**2.8**
7	MN Duluth	Wood frame, double pane	20.63	1448.21	1468.84	--	--	--	
7	MN Duluth	with exterior clear panel	16.76	1353.33	1370.09	$98.75	6.7%	22.9	
7	MN Duluth	with interior clear panel	17.9	1331.16	1349.06	$119.78	8.2%	18.8	
7	MN Duluth	with exterior low-e panel	14.59	1299.38	1313.97	$154.87	**10.5%**	**16.2**	**4.5**
7	MN Duluth	with interior low-e panel	16.76	1265.96	1282.72	$186.12	**12.7%**	**13.5**	**3.8**
7	MN Duluth	Metal frame, double pane	18.13	1574.57	1592.7	--	--	--	
7	MN Duluth	with exterior clear panel	17.56	1402.77	1420.33	$172.37	10.8%	13.1	
7	MN Duluth	with interior clear panel	17.1	1379.85	1396.95	$195.75	12.3%	11.5	
7	MN Duluth	with exterior low-e panel	15.73	1327.95	1343.68	$249.02	**15.6%**	**10.1**	**3.3**
7	MN Duluth	with interior low-e panel	16.3	1300.94	1317.24	$275.46	**17.3%**	**9.1**	**3.2**
7	MN Duluth	with exterior clear panel, worst case mounting	16.76	1464.14	1480.9	$111.80	7.0%	20.2	
7	MN Duluth	with exterior low-e panel, worst case mounting	14.14	1419.75	1433.89	$158.81	10.0%	15.8	
6	MN Minneapolis	Wood frame, single pane	90.96	1272.24	1363.2	--	--	--	
6	MN Minneapolis	with exterior clear panel	78.57	999.59	1078.16	$285.04	20.9%	7.9	
6	MN Minneapolis	with interior clear panel	78.66	984.34	1063	$300.20	22.0%	7.5	
6	MN Minneapolis	with exterior low-e panel	70.57	946.85	1017.42	$345.78	**25.4%**	**7.3**	**4.2**
6	MN Minneapolis	with interior low-e panel	76.49	914.31	990.8	$372.40	**27.3%**	**6.7**	**3.5**
6	MN Minneapolis	Wood frame, double pane	84.25	1060.08	1144.33	--	--	--	
6	MN Minneapolis	with exterior clear panel	75.01	985.7	1060.71	$83.62	7.3%	27.0	
6	MN Minneapolis	with interior clear panel	77.41	968.35	1045.76	$98.57	8.6%	22.9	
6	MN Minneapolis	with exterior low-e panel	67.26	943.56	1010.82	$133.51	**11.7%**	**18.8**	**5.1**
6	MN Minneapolis	with interior low-e panel	73.87	917.15	991.02	$153.31	**13.4%**	**16.4**	**4.7**
6	MN Minneapolis	Metal frame, double pane	79.8	1158.66	1238.46	--	--	--	
6	MN Minneapolis	with exterior clear panel	77.75	1024.24	1101.99	$136.47	11.0%	16.5	
6	MN Minneapolis	with interior clear panel	76.27	1006.27	1082.54	$155.92	12.6%	14.5	
6	MN Minneapolis	with exterior low-e panel	69.54	965.69	1035.23	$203.23	**16.4%**	**12.4**	**3.8**
6	MN Minneapolis	with interior low-e panel	72.39	944.49	1016.88	$221.58	**17.9%**	**11.3**	**3.9**
6	MN Minneapolis	with exterior clear panel, worst case mounting	74.78	1072.19	1146.97	$91.49	7.4%	24.7	
6	MN Minneapolis	with exterior low-e panel, worst case mounting	66.46	1037.5	1103.96	$134.50	10.9%	18.7	

Climate Zone	Location	Window	HVAC	Whole House Cooling		Whole House Heating		Source Energy		% source energy savings
6	VT Burlington	Wood frame, single pane	Furnace / AC	454	kWh	155	MBtu	174.5	MBtu	--
6	VT Burlington	with exterior clear panel	Furnace / AC	388	kWh	122.2	MBtu	137.9	MBtu	21.0%
6	VT Burlington	with interior clear panel	Furnace / AC	389	kWh	120.3	MBtu	135.8	MBtu	22.1%
6	VT Burlington	with exterior low-e panel	Furnace / AC	340	kWh	115.6	MBtu	130.1	MBtu	**25.4%**
6	VT Burlington	with interior low-e panel	Furnace / AC	377	kWh	111.6	MBtu	126.2	MBtu	**27.7%**
6	VT Burlington	Wood frame, double pane	Furnace / AC	418	kWh	129.5	MBtu	146.2	MBtu	--
6	VT Burlington	with exterior clear panel	Furnace / AC	367	kWh	120.6	MBtu	135.9	MBtu	7.0%
6	VT Burlington	with interior clear panel	Furnace / AC	380	kWh	118.4	MBtu	133.7	MBtu	8.6%
6	VT Burlington	with exterior low-e panel	Furnace / AC	320	kWh	115.2	MBtu	129.5	MBtu	**11.4%**
6	VT Burlington	with interior low-e panel	Furnace / AC	362	kWh	112	MBtu	126.5	MBtu	**13.5%**
6	VT Burlington	Metal frame, double pane	Furnace / AC	391	kWh	141.7	MBtu	159.2	MBtu	--
6	VT Burlington	with exterior clear panel	Furnace / AC	381	kWh	125.3	MBtu	141.2	MBtu	11.3%
6	VT Burlington	with interior clear panel	Furnace / AC	372	kWh	123.2	MBtu	138.8	MBtu	12.8%
6	VT Burlington	with exterior low-e panel	Furnace / AC	334	kWh	118	MBtu	132.7	MBtu	**16.7%**
6	VT Burlington	with interior low-e panel	Furnace / AC	352	kWh	115.4	MBtu	130.1	MBtu	**18.3%**
6	VT Burlington	with exterior clear panel, worst case mounting	Furnace / AC	363	kWh	131.3	MBtu	147.5	MBtu	7.3%
6	VT Burlington	with exterior low-e panel, worst case mounting	Furnace / AC	317	kWh	126.9	MBtu	142.2	MBtu	10.7%
5	CO Denver	Wood frame, single pane	Furnace / AC	973	kWh	109.3	MBtu	130.5	MBtu	--
5	CO Denver	with exterior clear panel	Furnace / AC	865	kWh	87	MBtu	104.9	MBtu	19.6%
5	CO Denver	with interior clear panel	Furnace / AC	867	kWh	85.8	MBtu	103.6	MBtu	20.6%
5	CO Denver	with exterior low-e panel	Furnace / AC	779	kWh	82.3	MBtu	98.8	MBtu	**24.3%**
5	CO Denver	with interior low-e panel	Furnace / AC	842	kWh	79	MBtu	95.9	MBtu	**26.5%**
5	CO Denver	Wood frame, double pane	Furnace / AC	917	kWh	91.8	MBtu	110.8	MBtu	--
5	CO Denver	with exterior clear panel	Furnace / AC	827	kWh	86.1	MBtu	103.5	MBtu	6.6%
5	CO Denver	with interior clear panel	Furnace / AC	853	kWh	84.5	MBtu	102.1	MBtu	7.9%
5	CO Denver	with exterior low-e panel	Furnace / AC	745	kWh	82.3	MBtu	98.4	MBtu	**11.1%**
5	CO Denver	with interior low-e panel	Furnace / AC	813	kWh	79.5	MBtu	96.1	MBtu	**13.2%**
5	CO Denver	Metal frame, double pane	Furnace / AC	879	kWh	101.7	MBtu	121.1	MBtu	--
5	CO Denver	with exterior clear panel	Furnace / AC	856	kWh	89.7	MBtu	107.8	MBtu	11.0%
5	CO Denver	with interior clear panel	Furnace / AC	841	kWh	88.3	MBtu	106.1	MBtu	12.4%
5	CO Denver	with exterior low-e panel	Furnace / AC	771	kWh	84.3	MBtu	100.9	MBtu	**16.7%**
5	CO Denver	with interior low-e panel	Furnace / AC	800	kWh	82.2	MBtu	98.9	MBtu	**18.3%**
5	CO Denver	with exterior clear panel, worst case mounting	Furnace / AC	830	kWh	94.6	MBtu	112.8	MBtu	6.9%
5	CO Denver	with exterior low-e panel, worst case mounting	Furnace / AC	746	kWh	91.6	MBtu	108.6	MBtu	10.4%

Climate Zone	Location	Window	Cooling Cost ($)	Heating Cost ($)	Total Cost ($)	Energy cost savings	% energy cost savings	Simple payback	Payback for low-e
6	VT Burlington	Wood frame, single pane	78.59	2534.43	2613.02	--	--	--	
6	VT Burlington	with exterior clear panel	67.12	1997.89	2065.01	$548.01	21.0%	4.1	
6	VT Burlington	with interior clear panel	67.3	1967.56	2034.86	$578.16	22.1%	3.9	
6	VT Burlington	with exterior low-e panel	58.82	1890.27	1949.09	$663.93	**25.4%**	**3.8**	**2.2**
6	VT Burlington	with interior low-e panel	65.22	1824.17	1889.39	$723.63	**27.7%**	**3.5**	**1.8**
6	VT Burlington	Wood frame, double pane	72.31	2117.37	2189.68	--	--	--	
6	VT Burlington	with exterior clear panel	63.49	1971.09	2034.58	$155.10	7.1%	14.6	
6	VT Burlington	with interior clear panel	65.74	1936.35	2002.09	$187.59	8.6%	12.0	
6	VT Burlington	with exterior low-e panel	55.36	1884.26	1939.62	$250.06	**11.4%**	**10.0**	**2.7**
6	VT Burlington	with interior low-e panel	62.63	1830.73	1893.36	$296.32	**13.5%**	**8.5**	**2.3**
6	VT Burlington	Metal frame, double pane	67.64	2316.88	2384.52	--	--	--	
6	VT Burlington	with exterior clear panel	65.91	2049.24	2115.15	$269.37	11.3%	8.4	
6	VT Burlington	with interior clear panel	64.36	2013.5	2077.86	$306.66	12.9%	7.4	
6	VT Burlington	with exterior low-e panel	57.78	1928.89	1986.67	$397.85	**16.7%**	**6.3**	**2.0**
6	VT Burlington	with interior low-e panel	60.9	1886.27	1947.17	$437.35	**18.3%**	**5.7**	**2.0**
6	VT Burlington	with exterior clear panel, worst case mounting	62.8	2146.15	2208.95	$175.57	7.4%	12.9	
6	VT Burlington	with exterior low-e panel, worst case mounting	54.84	2075.44	2130.28	$254.24	10.7%	9.9	
5	CO Denver	Wood frame, single pane	110.63	881.79	992.42	--	--	--	
5	CO Denver	with exterior clear panel	98.61	702.45	801.06	$191.36	19.3%	11.8	
5	CO Denver	with interior clear panel	98.84	692.17	791.01	$201.41	20.3%	11.2	
5	CO Denver	with exterior low-e panel	88.81	664.54	753.35	$239.07	**24.1%**	**10.5**	**5.3**
5	CO Denver	with interior low-e panel	95.99	637.13	733.12	$259.30	**26.1%**	**9.7**	**4.4**
5	CO Denver	Wood frame, double pane	104.54	741.08	845.62	--	--	--	
5	CO Denver	with exterior clear panel	94.28	694.91	789.19	$56.43	6.7%	40.0	
5	CO Denver	with interior clear panel	97.24	681.71	778.95	$66.67	7.9%	33.8	
5	CO Denver	with exterior low-e panel	84.93	664.35	749.28	$96.34	**11.4%**	**26.1**	**6.4**
5	CO Denver	with interior low-e panel	92.68	641.31	733.99	$111.63	**13.2%**	**22.5**	**5.7**
5	CO Denver	Metal frame, double pane	100.21	820.86	921.07	--	--	--	
5	CO Denver	with exterior clear panel	97.58	724.26	821.84	$99.23	10.8%	22.7	
5	CO Denver	with interior clear panel	95.87	712.48	808.35	$112.72	12.2%	20.0	
5	CO Denver	with exterior low-e panel	87.89	680.7	768.59	$152.48	**16.6%**	**16.5**	**4.8**
5	CO Denver	with interior low-e panel	91.2	663.71	754.91	$166.16	**18.0%**	**15.1**	**4.8**
5	CO Denver	with exterior clear panel, worst case mounting	94.62	763.31	857.93	$63.14	6.9%	35.7	
5	CO Denver	with exterior low-e panel, worst case mounting	85.04	738.95	823.99	$97.08	10.5%	25.9	

Climate Zone	Location	Window	HVAC	Whole House Cooling		Whole House Heating		Source Energy		% source energy savings
5	ID Boise	Wood frame, single pane	Furnace / AC	1184	kWh	110.4	MBtu	134.2	MBtu	--
5	ID Boise	with exterior clear panel	Furnace / AC	1041	kWh	87.3	MBtu	107.3	MBtu	20.0%
5	ID Boise	with interior clear panel	Furnace / AC	1042	kWh	86.1	MBtu	106.0	MBtu	21.0%
5	ID Boise	with exterior low-e panel	Furnace / AC	945	kWh	82.5	MBtu	100.9	MBtu	**24.8%**
5	ID Boise	with interior low-e panel	Furnace / AC	1006	kWh	79.2	MBtu	98.0	MBtu	**26.9%**
5	ID Boise	Wood frame, double pane	Furnace / AC	1101	kWh	92.4	MBtu	113.5	MBtu	--
5	ID Boise	with exterior clear panel	Furnace / AC	1003	kWh	86.4	MBtu	105.9	MBtu	6.8%
5	ID Boise	with interior clear panel	Furnace / AC	1026	kWh	84.8	MBtu	104.4	MBtu	8.1%
5	ID Boise	with exterior low-e panel	Furnace / AC	905	kWh	82.4	MBtu	100.4	MBtu	**11.6%**
5	ID Boise	with interior low-e panel	Furnace / AC	977	kWh	79.7	MBtu	98.3	MBtu	**13.5%**
5	ID Boise	Metal frame, double pane	Furnace / AC	1075	kWh	102.1	MBtu	123.8	MBtu	--
5	ID Boise	with exterior clear panel	Furnace / AC	1039	kWh	90	MBtu	110.2	MBtu	11.0%
5	ID Boise	with interior clear panel	Furnace / AC	1021	kWh	88.5	MBtu	108.4	MBtu	12.5%
5	ID Boise	with exterior low-e panel	Furnace / AC	937	kWh	84.4	MBtu	102.9	MBtu	**16.9%**
5	ID Boise	with interior low-e panel	Furnace / AC	968	kWh	82.4	MBtu	101.1	MBtu	**18.4%**
5	ID Boise	with exterior clear panel, worst case mounting	Furnace / AC	1017	kWh	94.7	MBtu	115.1	MBtu	7.1%
5	ID Boise	with exterior low-e panel, worst case mounting	Furnace / AC	919	kWh	91.5	MBtu	110.5	MBtu	10.8%
5	IL Chicago	Wood frame, single pane	Furnace / AC	979	kWh	134.6	MBtu	158.2	MBtu	--
5	IL Chicago	with exterior clear panel	Furnace / AC	862	kWh	105.9	MBtu	125.5	MBtu	20.7%
5	IL Chicago	with interior clear panel	Furnace / AC	864	kWh	104.3	MBtu	123.8	MBtu	21.7%
5	IL Chicago	with exterior low-e panel	Furnace / AC	787	kWh	100.2	MBtu	118.5	MBtu	**25.1%**
5	IL Chicago	with interior low-e panel	Furnace / AC	847	kWh	96.7	MBtu	115.3	MBtu	**27.1%**
5	IL Chicago	Wood frame, double pane	Furnace / AC	912	kWh	112.3	MBtu	133.1	MBtu	--
5	IL Chicago	with exterior clear panel	Furnace / AC	831	kWh	104.5	MBtu	123.7	MBtu	7.1%
5	IL Chicago	with interior clear panel	Furnace / AC	851	kWh	102.7	MBtu	121.9	MBtu	8.4%
5	IL Chicago	with exterior low-e panel	Furnace / AC	750	kWh	99.9	MBtu	117.7	MBtu	**11.6%**
5	IL Chicago	with interior low-e panel	Furnace / AC	820	kWh	97.1	MBtu	115.4	MBtu	**13.3%**
5	IL Chicago	Metal frame, double pane	Furnace / AC	875	kWh	123	MBtu	144.4	MBtu	--
5	IL Chicago	with exterior clear panel	Furnace / AC	852	kWh	108.7	MBtu	128.5	MBtu	11.0%
5	IL Chicago	with interior clear panel	Furnace / AC	842	kWh	106.8	MBtu	126.3	MBtu	12.5%
5	IL Chicago	with exterior low-e panel	Furnace / AC	777	kWh	102.2	MBtu	120.5	MBtu	**16.5%**
5	IL Chicago	with interior low-e panel	Furnace / AC	807	kWh	100	MBtu	118.5	MBtu	**17.9%**
5	IL Chicago	with exterior clear panel, worst case mounting	Furnace / AC	827	kWh	113.9	MBtu	133.9	MBtu	7.3%
5	IL Chicago	with exterior low-e panel, worst case mounting	Furnace / AC	751	kWh	110	MBtu	128.7	MBtu	10.8%

Climate Zone	Location	Window	Cooling Cost ($)	Heating Cost ($)	Total Cost ($)	Energy cost savings	% energy cost savings	Simple payback	Payback for low-e
5	ID Boise	Wood frame, single pane	100.28	903.18	1003.46	--	--	--	
5	ID Boise	with exterior clear panel	88.49	714.47	802.96	$200.50	20.0%	11.3	
5	ID Boise	with interior clear panel	88.57	703.91	792.48	$210.98	21.0%	10.7	
5	ID Boise	with exterior low-e panel	80.33	674.6	754.93	$248.53	**24.8%**	**10.1**	**5.3**
5	ID Boise	with interior low-e panel	85.51	648.09	733.6	$269.86	**26.9%**	**9.3**	**4.3**
5	ID Boise	Wood frame, double pane	93.59	755.8	849.39	--	--	--	
5	ID Boise	with exterior clear panel	85.26	706.42	791.68	$57.71	6.8%	39.1	
5	ID Boise	with interior clear panel	87.21	693.32	780.53	$68.86	8.1%	32.8	
5	ID Boise	with exterior low-e panel	76.93	673.82	750.75	$98.64	**11.6%**	**25.5**	**6.2**
5	ID Boise	with interior low-e panel	83.05	651.87	734.92	$114.47	**13.5%**	**21.9**	**5.6**
5	ID Boise	Metal frame, double pane	91.38	835.15	926.53	--	--	--	
5	ID Boise	with exterior clear panel	88.32	736.26	824.58	$101.95	11.0%	22.1	
5	ID Boise	with interior clear panel	86.79	723.68	810.47	$116.06	12.5%	19.4	
5	ID Boise	with exterior low-e panel	79.65	690.69	770.34	$156.19	**16.9%**	**16.1**	**4.7**
5	ID Boise	with interior low-e panel	82.28	673.84	756.12	$170.41	**18.4%**	**14.7**	**4.7**
5	ID Boise	with exterior clear panel, worst case mounting	86.45	774.77	861.22	$65.31	7.0%	34.6	
5	ID Boise	with exterior low-e panel, worst case mounting	78.12	748.58	826.7	$99.83	10.8%	25.2	
5	IL Chicago	Wood frame, single pane	111.31	1082.3	1193.61	--	--	--	
5	IL Chicago	with exterior clear panel	98.27	851.25	949.52	$244.09	20.4%	9.2	
5	IL Chicago	with interior clear panel	98.5	838.38	936.88	$256.73	21.5%	8.8	
5	IL Chicago	with exterior low-e panel	89.72	805.39	895.11	$298.50	**25.0%**	**8.4**	**4.7**
5	IL Chicago	with interior low-e panel	96.56	777.57	874.13	$319.48	**26.8%**	**7.9**	**4.1**
5	IL Chicago	Wood frame, double pane	103.97	902.57	1006.54	--	--	--	
5	IL Chicago	with exterior clear panel	94.73	840.44	935.17	$71.37	7.1%	31.6	
5	IL Chicago	with interior clear panel	97.01	825.72	922.73	$83.81	8.3%	26.9	
5	IL Chicago	with exterior low-e panel	85.5	802.91	888.41	$118.13	**11.7%**	**21.3**	**5.5**
5	IL Chicago	with interior low-e panel	93.48	780.46	873.94	$132.60	**13.2%**	**18.9**	**5.2**
5	IL Chicago	Metal frame, double pane	99.75	988.59	1088.34	--	--	--	
5	IL Chicago	with exterior clear panel	97.13	873.8	970.93	$117.41	10.8%	19.2	
5	IL Chicago	with interior clear panel	95.99	858.36	954.35	$133.99	12.3%	16.8	
5	IL Chicago	with exterior low-e panel	88.58	822.04	910.62	$177.72	**16.3%**	**14.1**	**4.2**
5	IL Chicago	with interior low-e panel	92	803.88	895.88	$192.46	**17.7%**	**13.1**	**4.4**
5	IL Chicago	with exterior clear panel, worst case mounting	94.28	915.47	1009.75	$78.59	7.2%	28.7	
5	IL Chicago	with exterior low-e panel, worst case mounting	85.61	884.43	970.04	$118.30	10.9%	21.2	

Climate Zone	Location	Window	HVAC	Whole House Cooling		Whole House Heating		Source Energy		% source energy savings
5	MA Boston	Wood frame, single pane	Furnace / AC	613	kWh	119.5	MBtu	137.5	MBtu	--
5	MA Boston	with exterior clear panel	Furnace / AC	546	kWh	91.3	MBtu	106.0	MBtu	23.0%
5	MA Boston	with interior clear panel	Furnace / AC	547	kWh	89.7	MBtu	104.2	MBtu	24.2%
5	MA Boston	with exterior low-e panel	Furnace / AC	493	kWh	86.1	MBtu	99.7	MBtu	**27.5%**
5	MA Boston	with interior low-e panel	Furnace / AC	539	kWh	82.5	MBtu	96.3	MBtu	**30.0%**
5	MA Boston	Wood frame, double pane	Furnace / AC	580	kWh	97.4	MBtu	113.0	MBtu	--
5	MA Boston	with exterior clear panel	Furnace / AC	522	kWh	90.1	MBtu	104.4	MBtu	7.6%
5	MA Boston	with interior clear panel	Furnace / AC	539	kWh	88.2	MBtu	102.5	MBtu	9.3%
5	MA Boston	with exterior low-e panel	Furnace / AC	467	kWh	85.9	MBtu	99.2	MBtu	**12.3%**
5	MA Boston	with interior low-e panel	Furnace / AC	521	kWh	82.9	MBtu	96.5	MBtu	**14.6%**
5	MA Boston	Metal frame, double pane	Furnace / AC	550	kWh	107.9	MBtu	124.1	MBtu	--
5	MA Boston	with exterior clear panel	Furnace / AC	537	kWh	94	MBtu	108.8	MBtu	12.3%
5	MA Boston	with interior clear panel	Furnace / AC	527	kWh	92.1	MBtu	106.6	MBtu	14.1%
5	MA Boston	with exterior low-e panel	Furnace / AC	483	kWh	88.1	MBtu	101.8	MBtu	**18.0%**
5	MA Boston	with interior low-e panel	Furnace / AC	506	kWh	85.7	MBtu	99.4	MBtu	**19.9%**
5	MA Boston	with exterior clear panel, worst case mounting	Furnace / AC	520	kWh	99.1	MBtu	114.2	MBtu	8.0%
5	MA Boston	with exterior low-e panel, worst case mounting	Furnace / AC	468	kWh	95.6	MBtu	109.8	MBtu	11.6%
5	NY Rochester	Wood frame, single pane	Furnace / AC	852	kWh	147.3	MBtu	170.6	MBtu	--
5	NY Rochester	with exterior clear panel	Furnace / AC	753	kWh	117.4	MBtu	136.8	MBtu	19.8%
5	NY Rochester	with interior clear panel	Furnace / AC	754	kWh	115.8	MBtu	135.1	MBtu	20.8%
5	NY Rochester	with exterior low-e panel	Furnace / AC	683	kWh	111.4	MBtu	129.5	MBtu	**24.1%**
5	NY Rochester	with interior low-e panel	Furnace / AC	737	kWh	107.9	MBtu	126.3	MBtu	**26.0%**
5	NY Rochester	Wood frame, double pane	Furnace / AC	800	kWh	124.1	MBtu	144.7	MBtu	--
5	NY Rochester	with exterior clear panel	Furnace / AC	721	kWh	116	MBtu	135.0	MBtu	6.7%
5	NY Rochester	with interior clear panel	Furnace / AC	742	kWh	114.2	MBtu	133.2	MBtu	7.9%
5	NY Rochester	with exterior low-e panel	Furnace / AC	655	kWh	111.1	MBtu	128.8	MBtu	**11.0%**
5	NY Rochester	with interior low-e panel	Furnace / AC	715	kWh	108.3	MBtu	126.5	MBtu	**12.6%**
5	NY Rochester	Metal frame, double pane	Furnace / AC	762	kWh	135	MBtu	156.2	MBtu	--
5	NY Rochester	with exterior clear panel	Furnace / AC	744	kWh	120.4	MBtu	140.0	MBtu	10.3%
5	NY Rochester	with interior clear panel	Furnace / AC	731	kWh	118.3	MBtu	137.6	MBtu	11.9%
5	NY Rochester	with exterior low-e panel	Furnace / AC	675	kWh	113.6	MBtu	131.8	MBtu	**15.6%**
5	NY Rochester	with interior low-e panel	Furnace / AC	701	kWh	111.3	MBtu	129.6	MBtu	**17.0%**
5	NY Rochester	with exterior clear panel, worst case mounting	Furnace / AC	720	kWh	125.6	MBtu	145.4	MBtu	6.9%
5	NY Rochester	with exterior low-e panel, worst case mounting	Furnace / AC	650	kWh	121.4	MBtu	140.0	MBtu	10.3%

Climate Zone	Location	Window	Cooling Cost ($)	Heating Cost ($)	Total Cost ($)	Energy cost savings	% energy cost savings	Simple payback	Payback for low-e
5	MA Boston	Wood frame, single pane	91.34	1613.91	1705.25	--	--	--	
5	MA Boston	with exterior clear panel	81.35	1231.92	1313.27	$391.98	23.0%	5.8	
5	MA Boston	with interior clear panel	81.5	1210.5	1292	$413.25	24.2%	5.5	
5	MA Boston	with exterior low-e panel	73.46	1161.97	1235.43	$469.82	**27.6%**	**5.3**	**3.3**
5	MA Boston	with interior low-e panel	80.31	1114.37	1194.68	$510.57	**29.9%**	**4.9**	**2.6**
5	MA Boston	Wood frame, double pane	86.42	1314.81	1401.23	--	--	--	
5	MA Boston	with exterior clear panel	77.78	1216.71	1294.49	$106.74	7.6%	21.1	
5	MA Boston	with interior clear panel	80.31	1191	1271.31	$129.92	9.3%	17.4	
5	MA Boston	with exterior low-e panel	69.58	1159.33	1228.91	$172.32	**12.3%**	**14.6**	**3.9**
5	MA Boston	with interior low-e panel	77.63	1119.61	1197.24	$203.99	**14.6%**	**12.3**	**3.4**
5	MA Boston	Metal frame, double pane	81.95	1456.47	1538.42	--	--	--	
5	MA Boston	with exterior clear panel	80.01	1269.14	1349.15	$189.27	12.3%	11.9	
5	MA Boston	with interior clear panel	78.52	1243.8	1322.32	$216.10	14.0%	10.4	
5	MA Boston	with exterior low-e panel	71.97	1189.17	1261.14	$277.28	**18.0%**	**9.1**	**2.9**
5	MA Boston	with interior low-e panel	75.39	1157.56	1232.95	$305.47	**19.9%**	**8.2**	**2.9**
5	MA Boston	with exterior clear panel, worst case mounting	77.48	1337.49	1414.97	$123.45	8.0%	18.3	
5	MA Boston	with exterior low-e panel, worst case mounting	69.73	1290.75	1360.48	$177.94	11.6%	14.1	
5	NY Rochester	Wood frame, single pane	150.8	1973.28	2124.08	--	--	--	
5	NY Rochester	with exterior clear panel	133.28	1573.54	1706.82	$417.26	19.6%	5.4	
5	NY Rochester	with interior clear panel	133.46	1551.69	1685.15	$438.93	20.7%	5.1	
5	NY Rochester	with exterior low-e panel	120.89	1492.92	1613.81	$510.27	**24.0%**	**4.9**	**2.7**
5	NY Rochester	with interior low-e panel	130.45	1446.36	1576.81	$547.27	**25.8%**	**4.6**	**2.4**
5	NY Rochester	Wood frame, double pane	141.6	1663.58	1805.18	--	--	--	
5	NY Rochester	with exterior clear panel	127.62	1554.69	1682.31	$122.87	6.8%	18.4	
5	NY Rochester	with interior clear panel	131.33	1530.29	1661.62	$143.56	8.0%	15.7	
5	NY Rochester	with exterior low-e panel	115.94	1488.24	1604.18	$201.00	**11.1%**	**12.5**	**3.3**
5	NY Rochester	with interior low-e panel	126.56	1451.41	1577.97	$227.21	**12.6%**	**11.1**	**3.0**
5	NY Rochester	Metal frame, double pane	134.87	1808.84	1943.71	--	--	--	
5	NY Rochester	with exterior clear panel	131.69	1612.78	1744.47	$199.24	10.3%	11.3	
5	NY Rochester	with interior clear panel	129.39	1585.84	1715.23	$228.48	11.8%	9.9	
5	NY Rochester	with exterior low-e panel	119.48	1521.97	1641.45	$302.26	**15.6%**	**8.3**	**2.5**
5	NY Rochester	with interior low-e panel	124.08	1491.27	1615.35	$328.36	**16.9%**	**7.6**	**2.6**
5	NY Rochester	with exterior clear panel, worst case mounting	127.44	1682.64	1810.08	$133.63	6.9%	16.9	
5	NY Rochester	with exterior low-e panel, worst case mounting	115.05	1627.26	1742.31	$201.40	10.4%	12.5	

Climate Zone	Location	Window	HVAC	Whole House Cooling		Whole House Heating		Source Energy		% source energy savings
5	PA Pittsburgh	Wood frame, single pane	Furnace / AC	916	kWh	122.6	MBtu	144.4	MBtu	--
5	PA Pittsburgh	with exterior clear panel	Furnace / AC	818	kWh	97.6	MBtu	116.0	MBtu	19.7%
5	PA Pittsburgh	with interior clear panel	Furnace / AC	818	kWh	96.2	MBtu	114.4	MBtu	20.7%
5	PA Pittsburgh	with exterior low-e panel	Furnace / AC	745	kWh	92.4	MBtu	109.5	MBtu	**24.2%**
5	PA Pittsburgh	with interior low-e panel	Furnace / AC	801	kWh	89.2	MBtu	106.6	MBtu	**26.2%**
5	PA Pittsburgh	Wood frame, double pane	Furnace / AC	863	kWh	103.2	MBtu	122.6	MBtu	--
5	PA Pittsburgh	with exterior clear panel	Furnace / AC	784	kWh	96.4	MBtu	114.3	MBtu	6.8%
5	PA Pittsburgh	with interior clear panel	Furnace / AC	806	kWh	94.8	MBtu	112.8	MBtu	8.0%
5	PA Pittsburgh	with exterior low-e panel	Furnace / AC	715	kWh	92.1	MBtu	108.8	MBtu	**11.3%**
5	PA Pittsburgh	with interior low-e panel	Furnace / AC	775	kWh	89.6	MBtu	106.7	MBtu	**12.9%**
5	PA Pittsburgh	Metal frame, double pane	Furnace / AC	825	kWh	112.9	MBtu	132.8	MBtu	--
5	PA Pittsburgh	with exterior clear panel	Furnace / AC	809	kWh	100.2	MBtu	118.7	MBtu	10.6%
5	PA Pittsburgh	with interior clear panel	Furnace / AC	794	kWh	98.5	MBtu	116.7	MBtu	12.1%
5	PA Pittsburgh	with exterior low-e panel	Furnace / AC	736	kWh	94.3	MBtu	111.4	MBtu	**16.1%**
5	PA Pittsburgh	with interior low-e panel	Furnace / AC	763	kWh	92.3	MBtu	109.6	MBtu	**17.5%**
5	PA Pittsburgh	with exterior clear panel, worst case mounting	Furnace / AC	779	kWh	104.9	MBtu	123.5	MBtu	7.0%
5	PA Pittsburgh	with exterior low-e panel, worst case mounting	Furnace / AC	710	kWh	101.4	MBtu	118.9	MBtu	10.5%
4	NY New York City	Wood frame, single pane	Furnace / AC	1185	kWh	109.7	MBtu	133.4	MBtu	--
4	NY New York City	with exterior clear panel	Furnace / AC	1073	kWh	85.5	MBtu	105.7	MBtu	20.8%
4	NY New York City	with interior clear panel	Furnace / AC	1073	kWh	84.1	MBtu	104.2	MBtu	21.9%
4	NY New York City	with exterior low-e panel	Furnace / AC	996	kWh	81	MBtu	99.9	MBtu	**25.1%**
4	NY New York City	with interior low-e panel	Furnace / AC	1052	kWh	77.9	MBtu	97.1	MBtu	**27.2%**
4	NY New York City	Wood frame, double pane	Furnace / AC	1128	kWh	90.8	MBtu	112.1	MBtu	--
4	NY New York City	with exterior clear panel	Furnace / AC	1041	kWh	84.6	MBtu	104.3	MBtu	6.9%
4	NY New York City	with interior clear panel	Furnace / AC	1064	kWh	82.9	MBtu	102.7	MBtu	8.4%
4	NY New York City	with exterior low-e panel	Furnace / AC	964	kWh	80.9	MBtu	99.4	MBtu	**11.3%**
4	NY New York City	with interior low-e panel	Furnace / AC	1028	kWh	78.3	MBtu	97.3	MBtu	**13.2%**
4	NY New York City	Metal frame, double pane	Furnace / AC	1089	kWh	100	MBtu	121.7	MBtu	--
4	NY New York City	with exterior clear panel	Furnace / AC	1065	kWh	88	MBtu	108.3	MBtu	11.0%
4	NY New York City	with interior clear panel	Furnace / AC	1050	kWh	86.4	MBtu	106.4	MBtu	12.6%
4	NY New York City	with exterior low-e panel	Furnace / AC	989	kWh	82.8	MBtu	101.8	MBtu	**16.4%**
4	NY New York City	with interior low-e panel	Furnace / AC	1016	kWh	80.8	MBtu	99.9	MBtu	**17.9%**
4	NY New York City	with exterior clear panel, worst case mounting	Furnace / AC	1039	kWh	92.4	MBtu	112.8	MBtu	7.3%
4	NY New York City	with exterior low-e panel, worst case mounting	Furnace / AC	964	kWh	89.4	MBtu	108.7	MBtu	10.7%

Climate Zone	Location	Window	Cooling Cost ($)	Heating Cost ($)	Total Cost ($)	Energy cost savings	% energy cost savings	Simple payback	Payback for low-e
5	PA Pittsburgh	Wood frame, single pane	117.25	1434.05	1551.3	--	--	--	
5	PA Pittsburgh	with exterior clear panel	104.7	1141.74	1246.44	$304.86	19.7%	7.4	
5	PA Pittsburgh	with interior clear panel	104.7	1125.45	1230.15	$321.15	20.7%	7.0	
5	PA Pittsburgh	with exterior low-e panel	95.36	1080.64	1176	$375.30	**24.2%**	**6.7**	**3.6**
5	PA Pittsburgh	with interior low-e panel	102.53	1044.13	1146.66	$404.64	**26.1%**	**6.2**	**3.1**
5	PA Pittsburgh	Wood frame, double pane	110.46	1207.22	1317.68	--	--	--	
5	PA Pittsburgh	with exterior clear panel	100.35	1128.21	1228.56	$89.12	6.8%	25.3	
5	PA Pittsburgh	with interior clear panel	103.17	1109.55	1212.72	$104.96	8.0%	21.5	
5	PA Pittsburgh	with exterior low-e panel	91.52	1077.82	1169.34	$148.34	**11.3%**	**16.9**	**4.3**
5	PA Pittsburgh	with interior low-e panel	99.2	1048.37	1147.57	$170.11	**12.9%**	**14.8**	**3.9**
5	PA Pittsburgh	Metal frame, double pane	105.6	1320.46	1426.06	--	--	--	
5	PA Pittsburgh	with exterior clear panel	103.55	1172.48	1276.03	$150.03	10.5%	15.0	
5	PA Pittsburgh	with interior clear panel	101.63	1152.8	1254.43	$171.63	12.0%	13.1	
5	PA Pittsburgh	with exterior low-e panel	94.21	1103.29	1197.5	$228.56	**16.0%**	**11.0**	**3.2**
5	PA Pittsburgh	with interior low-e panel	97.66	1079.7	1177.36	$248.70	**17.4%**	**10.1**	**3.3**
5	PA Pittsburgh	with exterior clear panel, worst case mounting	99.71	1227.45	1327.16	$98.90	6.9%	22.8	
5	PA Pittsburgh	with exterior low-e panel, worst case mounting	90.88	1185.82	1276.7	$149.36	10.5%	16.8	
4	NY NewYork City	Wood frame, single pane	209.75	1470.07	1679.82	--	--	--	
4	NY NewYork City	with exterior clear panel	189.92	1145.2	1335.12	$344.70	20.5%	6.5	
4	NY NewYork City	with interior clear panel	189.92	1127.07	1316.99	$362.83	21.6%	6.2	
4	NY NewYork City	with exterior low-e panel	176.29	1085.32	1261.61	$418.21	**24.9%**	**6.0**	**3.5**
4	NY NewYork City	with interior low-e panel	186.2	1043.48	1229.68	$450.14	**26.8%**	**5.6**	**2.9**
4	NY NewYork City	Wood frame, double pane	199.66	1216.09	1415.75	--	--	--	
4	NY NewYork City	with exterior clear panel	184.26	1133.37	1317.63	$98.12	6.9%	23.0	
4	NY NewYork City	with interior clear panel	188.33	1111.52	1299.85	$115.90	8.2%	19.5	
4	NY NewYork City	with exterior low-e panel	170.63	1084.27	1254.9	$160.85	**11.4%**	**15.6**	**4.1**
4	NY NewYork City	with interior low-e panel	181.96	1049.19	1231.15	$184.60	**13.0%**	**13.6**	**3.7**
4	NY NewYork City	Metal frame, double pane	192.75	1339.49	1532.24	--	--	--	
4	NY NewYork City	with exterior clear panel	188.51	1179.09	1367.6	$164.64	10.7%	13.7	
4	NY NewYork City	with interior clear panel	185.85	1157.48	1343.33	$188.91	12.3%	11.9	
4	NY NewYork City	with exterior low-e panel	175.05	1110.08	1285.13	$247.11	**16.1%**	**10.2**	**3.1**
4	NY NewYork City	with interior low-e panel	179.83	1082.41	1262.24	$270.00	**17.6%**	**9.3**	**3.1**
4	NY NewYork City	with exterior clear panel, worst case mounting	183.9	1238.56	1422.46	$109.78	7.2%	20.6	
4	NY NewYork City	with exterior low-e panel, worst case mounting	170.63	1198.31	1368.94	$163.30	10.7%	15.4	

Climate Zone	Location	Window	HVAC	Whole House Cooling		Whole House Heating		Source Energy		% source energy savings
4	WA Seattle	Wood frame, single pane	Furnace / AC	184	kWh	85.9	MBtu	95.9	MBtu	--
4	WA Seattle	with exterior clear panel	Furnace / AC	160	kWh	65.4	MBtu	73.3	MBtu	23.6%
4	WA Seattle	with interior clear panel	Furnace / AC	162	kWh	64.3	MBtu	72.1	MBtu	24.9%
4	WA Seattle	with exterior low-e panel	Furnace / AC	141	kWh	60.9	MBtu	68.1	MBtu	**29.0%**
4	WA Seattle	with interior low-e panel	Furnace / AC	161	kWh	58.2	MBtu	65.4	MBtu	**31.8%**
4	WA Seattle	Wood frame, double pane	Furnace / AC	173	kWh	70	MBtu	78.4	MBtu	--
4	WA Seattle	with exterior clear panel	Furnace / AC	150	kWh	64.6	MBtu	72.3	MBtu	7.9%
4	WA Seattle	with interior clear panel	Furnace / AC	159	kWh	63.3	MBtu	70.9	MBtu	9.5%
4	WA Seattle	with exterior low-e panel	Furnace / AC	130	kWh	60.7	MBtu	67.8	MBtu	**13.6%**
4	WA Seattle	with interior low-e panel	Furnace / AC	152	kWh	58.6	MBtu	65.7	MBtu	**16.2%**
4	WA Seattle	Metal frame, double pane	Furnace / AC	158	kWh	78.4	MBtu	87.4	MBtu	--
4	WA Seattle	with exterior clear panel	Furnace / AC	158	kWh	67.9	MBtu	76.0	MBtu	13.1%
4	WA Seattle	with interior clear panel	Furnace / AC	155	kWh	66.5	MBtu	74.4	MBtu	14.9%
4	WA Seattle	with exterior low-e panel	Furnace / AC	137	kWh	62.6	MBtu	69.9	MBtu	**20.0%**
4	WA Seattle	with interior low-e panel	Furnace / AC	147	kWh	60.9	MBtu	68.2	MBtu	**22.0%**
4	WA Seattle	with exterior clear panel, worst case mounting	Furnace / AC	148	kWh	71.9	MBtu	80.2	MBtu	8.3%
4	WA Seattle	with exterior low-e panel, worst case mounting	Furnace / AC	124	kWh	68.7	MBtu	76.4	MBtu	12.6%
4	DC Washington	Wood frame, single pane	Furnace / AC	1593	kWh	100.4	MBtu	127.9	MBtu	--
4	DC Washington	with exterior clear panel	Furnace / AC	1420	kWh	79.6	MBtu	103.2	MBtu	19.3%
4	DC Washington	with interior clear panel	Furnace / AC	1419	kWh	78.4	MBtu	101.9	MBtu	20.3%
4	DC Washington	with exterior low-e panel	Furnace / AC	1316	kWh	75.5	MBtu	97.6	MBtu	**23.7%**
4	DC Washington	with interior low-e panel	Furnace / AC	1381	kWh	72.5	MBtu	95.0	MBtu	**25.7%**
4	DC Washington	with exterior solar-E panel	Furnace / AC	1119	kWh	79.1	MBtu	99.2	MBtu	**22.4%**
4	DC Washington	Wood frame, double pane	Furnace / AC	1494	kWh	84.2	MBtu	109.1	MBtu	--
4	DC Washington	with exterior clear panel	Furnace / AC	1376	kWh	78.8	MBtu	101.8	MBtu	6.6%
4	DC Washington	with interior clear panel	Furnace / AC	1401	kWh	77.4	MBtu	100.6	MBtu	7.8%
4	DC Washington	with exterior low-e panel	Furnace / AC	1277	kWh	75.4	MBtu	97.0	MBtu	**11.1%**
4	DC Washington	with interior low-e panel	Furnace / AC	1351	kWh	73	MBtu	95.2	MBtu	**12.7%**
4	DC Washington	with exterior solar-E panel	Furnace / AC	1091	kWh	78.9	MBtu	98.7	MBtu	**9.5%**
4	DC Washington	Metal frame, double pane	Furnace / AC	1452	kWh	92.7	MBtu	117.9	MBtu	--
4	DC Washington	with exterior clear panel	Furnace / AC	1411	kWh	82	MBtu	105.7	MBtu	10.3%
4	DC Washington	with interior clear panel	Furnace / AC	1390	kWh	80.6	MBtu	104.0	MBtu	11.8%
4	DC Washington	with exterior low-e panel	Furnace / AC	1309	kWh	77.2	MBtu	99.3	MBtu	**15.7%**
4	DC Washington	with interior low-e panel	Furnace / AC	1341	kWh	75.3	MBtu	97.6	MBtu	**17.2%**
4	DC Washington	with exterior solar-E panel	Furnace / AC	1116	kWh	80.8	MBtu	101.0	MBtu	**14.3%**
4	DC Washington	with exterior clear panel, worst case mounting	Furnace / AC	1383	kWh	86.1	MBtu	109.9	MBtu	6.8%
4	DC Washington	with exterior low-e panel, worst case mounting	Furnace / AC	1284	kWh	83.4	MBtu	105.8	MBtu	10.2%
4	DC Washington	with exterior solar-E panel, worst case mount	Furnace / AC	1121	kWh	86.4	MBtu	107.2	MBtu	9.1%

Climate Zone	Location	Window	Cooling Cost ($)	Heating Cost ($)	Total Cost ($)	Energy cost savings	% energy cost savings	Simple payback	Payback for low-e
4	WA Seattle	Wood frame, single pane	15.64	998	1013.64	--	--	--	
4	WA Seattle	with exterior clear panel	13.6	760.39	773.99	$239.65	23.6%	9.4	
4	WA Seattle	with interior clear panel	13.77	747.46	761.23	$252.41	24.9%	8.9	
4	WA Seattle	with exterior low-e panel	11.99	707.44	719.43	$294.21	**29.0%**	**8.5**	**4.7**
4	WA Seattle	with interior low-e panel	13.69	676.75	690.44	$323.20	**31.9%**	**7.8**	**3.6**
4	WA Seattle	Wood frame, double pane	14.71	813.62	828.33	--	--	--	
4	WA Seattle	with exterior clear panel	12.75	750.62	763.37	$64.96	7.8%	34.7	
4	WA Seattle	with interior clear panel	13.52	735.43	748.95	$79.38	9.6%	28.4	
4	WA Seattle	with exterior low-e panel	11.05	705.54	716.59	$111.74	**13.5%**	**22.5**	**5.5**
4	WA Seattle	with interior low-e panel	12.92	680.87	693.79	$134.54	**16.2%**	**18.7**	**4.6**
4	WA Seattle	Metal frame, double pane	13.43	911.1	924.53	--	--	--	
4	WA Seattle	with exterior clear panel	13.43	788.7	802.13	$122.40	13.2%	18.4	
4	WA Seattle	with interior clear panel	13.18	772.28	785.46	$139.07	15.0%	16.2	
4	WA Seattle	with exterior low-e panel	11.65	727.24	738.89	$185.64	**20.1%**	**13.5**	**4.0**
4	WA Seattle	with interior low-e panel	12.5	707.22	719.72	$204.81	**22.2%**	**12.3**	**3.9**
4	WA Seattle	with exterior clear panel, worst case mounting	12.58	835.61	848.19	$76.34	8.3%	29.6	
4	WA Seattle	with exterior low-e panel, worst case mounting	10.54	798.76	809.3	$115.23	12.5%	21.8	
4	DC Washington	Wood frame, single pane	195.94	1282.3	1478.24	--	--	--	
4	DC Washington	with exterior clear panel	174.66	1016.98	1191.64	$286.60	19.4%	7.9	
4	DC Washington	with interior clear panel	174.54	1001.77	1176.31	$301.93	20.4%	7.5	
4	DC Washington	with exterior low-e panel	161.87	963.89	1125.76	$352.48	**23.8%**	**7.1**	**3.9**
4	DC Washington	with interior low-e panel	169.86	926.07	1095.93	$382.31	**25.9%**	**6.6**	**3.2**
4	DC Washington	with exterior solar-E panel	137.64	1010.29	1147.93	$330.31	**22.3%**	**7.6**	**5.8**
4	DC Washington	Wood frame, double pane	183.76	1075.55	1259.31	--	--	--	
4	DC Washington	with exterior clear panel	169.25	1006.74	1175.99	$83.32	6.6%	27.1	
4	DC Washington	with interior clear panel	172.32	987.82	1160.14	$99.17	7.9%	22.8	
4	DC Washington	with exterior low-e panel	157.07	963.25	1120.32	$138.99	**11.0%**	**18.1**	**4.6**
4	DC Washington	with interior low-e panel	166.17	931.76	1097.93	$161.38	**12.8%**	**15.6**	**4.1**
4	DC Washington	with exterior solar-E panel	134.19	1007.14	1141.33	$117.98	**9.4%**	**21.3**	**7.4**
4	DC Washington	Metal frame, double pane	178.6	1183.7	1362.3	--	--	--	
4	DC Washington	with exterior clear panel	173.55	1047.27	1220.82	$141.48	10.4%	16.0	
4	DC Washington	with interior clear panel	170.97	1029.4	1200.37	$161.93	11.9%	13.9	
4	DC Washington	with exterior low-e panel	161.01	985.95	1146.96	$215.34	**15.8%**	**11.7**	**3.5**
4	DC Washington	with interior low-e panel	164.94	961.93	1126.87	$235.43	**17.3%**	**10.7**	**3.5**
4	DC Washington	with exterior solar-E panel	137.27	1031.73	1169	$193.30	**14.2%**	**13.0**	**4.9**
4	DC Washington	with exterior clear panel, worst case mounting	170.11	1099.91	1270.02	$92.28	6.8%	24.5	
4	DC Washington	with exterior low-e panel, worst case mounting	157.93	1064.43	1222.36	$139.94	10.3%	17.9	
4	DC Washington	with exterior solar-E panel, worst case mounting	137.88	1103.95	1241.83	$120.47	8.8%	20.8	

Climate Zone	Location	Window	HVAC	Whole House Cooling		Whole House Heating		Source Energy		% source energy savings
4	MO Kansas City	Wood frame, single pane	Furnace / AC	2235	kWh	95.7	MBtu	130.2	MBtu	--
4	MO Kansas City	with exterior clear panel	Furnace / AC	1955	kWh	73	MBtu	102.2	MBtu	21.5%
4	MO Kansas City	with interior clear panel	Furnace / AC	1947	kWh	71.8	MBtu	100.8	MBtu	22.6%
4	MO Kansas City	with exterior low-e panel	Furnace / AC	1815	kWh	68.6	MBtu	95.8	MBtu	**26.4%**
4	MO Kansas City	with interior low-e panel	Furnace / AC	1895	kWh	65.6	MBtu	93.4	MBtu	**28.3%**
4	MO Kansas City	with exterior solar-E panel	Furnace / AC	1561	kWh	72.2	MBtu	96.8	MBtu	**25.7%**
4	MO Kansas City	Wood frame, double pane	Furnace / AC	2061	kWh	78	MBtu	108.8	MBtu	--
4	MO Kansas City	with exterior clear panel	Furnace / AC	1900	kWh	72.1	MBtu	100.5	MBtu	7.6%
4	MO Kansas City	with interior clear panel	Furnace / AC	1928	kWh	70.5	MBtu	99.1	MBtu	8.9%
4	MO Kansas City	with exterior low-e panel	Furnace / AC	1764	kWh	68.5	MBtu	95.1	MBtu	**12.7%**
4	MO Kansas City	with interior low-e panel	Furnace / AC	1858	kWh	66	MBtu	93.4	MBtu	**14.2%**
4	MO Kansas City	with exterior solar-E panel	Furnace / AC	1525	kWh	71.9	MBtu	96.0	MBtu	**11.8%**
4	MO Kansas City	Metal frame, double pane	Furnace / AC	2021	kWh	86.8	MBtu	118.0	MBtu	--
4	MO Kansas City	with exterior clear panel	Furnace / AC	1950	kWh	75.4	MBtu	104.7	MBtu	11.2%
4	MO Kansas City	with interior clear panel	Furnace / AC	1919	kWh	73.9	MBtu	102.7	MBtu	12.9%
4	MO Kansas City	with exterior low-e panel	Furnace / AC	1807	kWh	70.4	MBtu	97.6	MBtu	**17.3%**
4	MO Kansas City	with interior low-e panel	Furnace / AC	1843	kWh	68.4	MBtu	95.9	MBtu	**18.8%**
4	MO Kansas City	with exterior solar-E panel	Furnace / AC	1560	kWh	73.9	MBtu	98.6	MBtu	**16.4%**
4	MO Kansas City	with exterior clear panel, worst case mounting	Furnace / AC	1919	kWh	79.7	MBtu	109.1	MBtu	7.6%
4	MO Kansas City	with exterior low-e panel, worst case mounting	Furnace / AC	1780	kWh	76.8	MBtu	104.3	MBtu	11.6%
4	MO Kansas City	with exterior solar-E panel, worst case mountin	Furnace / AC	1574	kWh	79.8	MBtu	105.2	MBtu	10.8%
4	NC Raleigh	Wood frame, single pane	Furnace / AC	2682	kWh	88.9	MBtu	127.9	MBtu	--
4	NC Raleigh	with exterior clear panel	Furnace / AC	2444	kWh	73.4	MBtu	108.2	MBtu	15.4%
4	NC Raleigh	with interior clear panel	Furnace / AC	2438	kWh	72.4	MBtu	107.1	MBtu	16.3%
4	NC Raleigh	with exterior low-e panel	Furnace / AC	2312	kWh	70.3	MBtu	103.3	MBtu	**19.2%**
4	NC Raleigh	with interior low-e panel	Furnace / AC	2397	kWh	67.8	MBtu	101.6	MBtu	**20.6%**
4	NC Raleigh	with exterior solar-E panel	Furnace / AC	2066	kWh	73.5	MBtu	104.0	MBtu	**18.7%**
4	NC Raleigh	Wood frame, double pane	Furnace / AC	2545	kWh	76.8	MBtu	113.1	MBtu	--
4	NC Raleigh	with exterior clear panel	Furnace / AC	2390	kWh	72.9	MBtu	107.0	MBtu	5.3%
4	NC Raleigh	with interior clear panel	Furnace / AC	2420	kWh	71.7	MBtu	106.1	MBtu	6.2%
4	NC Raleigh	with exterior low-e panel	Furnace / AC	2262	kWh	70.4	MBtu	102.8	MBtu	**9.1%**
4	NC Raleigh	with interior low-e panel	Furnace / AC	2360	kWh	68.3	MBtu	101.7	MBtu	**10.1%**
4	NC Raleigh	with exterior solar-E panel	Furnace / AC	2031	kWh	73.5	MBtu	103.6	MBtu	**8.4%**
4	NC Raleigh	Metal frame, double pane	Furnace / AC	2497	kWh	83.7	MBtu	120.1	MBtu	--
4	NC Raleigh	with exterior clear panel	Furnace / AC	2438	kWh	75.4	MBtu	110.3	MBtu	8.1%
4	NC Raleigh	with interior clear panel	Furnace / AC	2408	kWh	74.4	MBtu	108.9	MBtu	9.3%
4	NC Raleigh	with exterior low-e panel	Furnace / AC	2303	kWh	71.7	MBtu	104.7	MBtu	**12.8%**
4	NC Raleigh	with interior low-e panel	Furnace / AC	2344	kWh	70.2	MBtu	103.6	MBtu	**13.7%**
4	NC Raleigh	with exterior solar-E panel	Furnace / AC	2064	kWh	75	MBtu	105.6	MBtu	**12.1%**
4	NC Raleigh	with exterior clear panel, worst case mounting	Furnace / AC	2402	kWh	78.8	MBtu	113.6	MBtu	5.4%
4	NC Raleigh	with exterior low-e panel, worst case mounting	Furnace / AC	2276	kWh	76.8	MBtu	110.0	MBtu	8.4%
4	NC Raleigh	with exterior solar-E panel, worst case mountin	Furnace / AC	2073	kWh	79.5	MBtu	110.6	MBtu	7.9%

Climate Zone	Location	Window	Cooling Cost ($)	Heating Cost ($)	Total Cost ($)	Energy cost savings	% energy cost savings	Simple payback	Payback for low-e
4	MO Kansas City	Wood frame, single pane	225.74	1150.84	1376.58	--	--	--	
4	MO Kansas City	with exterior clear panel	197.46	878.73	1076.19	$300.39	21.8%	7.5	
4	MO Kansas City	with interior clear panel	196.65	863.74	1060.39	$316.19	23.0%	7.1	
4	MO Kansas City	with exterior low-e panel	183.32	825.7	1009.02	$367.56	**26.7%**	**6.8**	**3.8**
4	MO Kansas City	with interior low-e panel	191.4	789.53	980.93	$395.65	**28.7%**	**6.3**	**3.2**
4	MO Kansas City	with exterior solar-E panel	157.66	868.47	1026.13	$350.45	**25.5%**	**7.2**	**5.1**
4	MO Kansas City	Wood frame, double pane	208.16	937.75	1145.91	--	--	--	
4	MO Kansas City	with exterior clear panel	191.9	866.99	1058.89	$87.02	7.6%	25.9	
4	MO Kansas City	with interior clear panel	194.73	848.57	1043.3	$102.61	9.0%	22.0	
4	MO Kansas City	with exterior low-e panel	178.16	823.83	1001.99	$143.92	**12.6%**	**17.5**	**4.5**
4	MO Kansas City	with interior low-e panel	187.66	793.82	981.48	$164.43	**14.3%**	**15.3**	**4.1**
4	MO Kansas City	with exterior solar-E panel	154.03	864.42	1018.45	$127.46	**11.1%**	**19.7**	**6.3**
4	MO Kansas City	Metal frame, double pane	204.12	1044.25	1248.37	--	--	--	
4	MO Kansas City	with exterior clear panel	196.95	906.87	1103.82	$144.55	11.6%	15.6	
4	MO Kansas City	with interior clear panel	193.82	888.98	1082.8	$165.57	13.3%	13.6	
4	MO Kansas City	with exterior low-e panel	182.51	846.37	1028.88	$219.49	**17.6%**	**11.4**	**3.4**
4	MO Kansas City	with interior low-e panel	186.14	823.29	1009.43	$238.94	**19.1%**	**10.5**	**3.5**
4	MO Kansas City	with exterior solar-E panel	157.56	888.6	1046.16	$202.21	**16.2%**	**12.4**	**4.4**
4	MO Kansas City	with exterior clear panel, worst case mounting	193.82	958.49	1152.31	$96.06	7.7%	23.5	
4	MO Kansas City	with exterior low-e panel, worst case mounting	179.78	923.56	1103.34	$145.03	11.6%	17.3	
4	MO Kansas City	with exterior solar-E panel, worst case mounting	158.97	959.73	1118.7	$129.67	10.4%	19.4	
4	NC Raleigh	Wood frame, single pane	289.66	1091.01	1380.67	--	--	--	
4	NC Raleigh	with exterior clear panel	263.95	900.2	1164.15	$216.52	15.7%	10.4	
4	NC Raleigh	with interior clear panel	263.3	888.9	1152.2	$228.47	16.5%	9.9	
4	NC Raleigh	with exterior low-e panel	249.7	862.29	1111.99	$268.68	**19.5%**	**9.3**	**4.9**
4	NC Raleigh	with interior low-e panel	258.88	832.45	1091.33	$289.34	**21.0%**	**8.7**	**4.2**
4	NC Raleigh	with exterior solar-E panel	223.13	902.4	1125.53	$255.14	**18.5%**	**9.8**	**6.6**
4	NC Raleigh	Wood frame, double pane	274.86	942.31	1217.17	--	--	--	
4	NC Raleigh	with exterior clear panel	258.12	895.02	1153.14	$64.03	5.3%	35.2	
4	NC Raleigh	with interior clear panel	261.36	880.24	1141.6	$75.57	6.2%	29.9	
4	NC Raleigh	with exterior low-e panel	244.3	863.39	1107.69	$109.48	**9.0%**	**22.9**	**5.6**
4	NC Raleigh	with interior low-e panel	254.88	837.76	1092.64	$124.53	**10.2%**	**20.2**	**5.2**
4	NC Raleigh	with exterior solar-E panel	219.35	901.44	1120.79	$96.38	**7.9%**	**26.1**	**7.9**
4	NC Raleigh	Metal frame, double pane	269.68	1027.1	1296.78	--	--	--	
4	NC Raleigh	with exterior clear panel	263.3	925.59	1188.89	$107.89	8.3%	20.9	
4	NC Raleigh	with interior clear panel	260.06	912.63	1172.69	$124.09	9.6%	18.2	
4	NC Raleigh	with exterior low-e panel	248.72	880.26	1128.98	$167.80	**12.9%**	**15.0**	**4.3**
4	NC Raleigh	with interior low-e panel	253.15	861.45	1114.6	$182.18	**14.0%**	**13.8**	**4.4**
4	NC Raleigh	with exterior solar-E panel	222.91	919.83	1142.74	$154.04	**11.9%**	**16.3**	**5.5**
4	NC Raleigh	with exterior clear panel, worst case mounting	259.42	966.97	1226.39	$70.39	5.4%	32.1	
4	NC Raleigh	with exterior low-e panel, worst case mounting	245.81	941.97	1187.78	$109.00	8.4%	23.0	
4	NC Raleigh	with exterior solar-E panel, worst case mounting	223.88	975.92	1199.8	$96.98	7.5%	25.9	

Climate Zone	Location	Window	HVAC	Whole House Cooling		Whole House Heating		Source Energy		% source energy savings
3	GA Atlanta	Wood frame, single pane	Furnace / AC	2904	kWh	43.9	MBtu	81.3	MBtu	--
3	GA Atlanta	with exterior clear panel	Furnace / AC	2696	kWh	31.7	MBtu	65.6	MBtu	19.3%
3	GA Atlanta	with interior clear panel	Furnace / AC	2689	kWh	31	MBtu	64.7	MBtu	20.4%
3	GA Atlanta	with exterior low-e panel	Furnace / AC	2566	kWh	29.3	MBtu	61.5	MBtu	**24.4%**
3	GA Atlanta	with interior low-e panel	Furnace / AC	2665	kWh	27.4	MBtu	60.5	MBtu	**25.5%**
3	GA Atlanta	with exterior solar-E panel	Furnace / AC	2288	kWh	31.8	MBtu	61.0	MBtu	**25.0%**
3	GA Atlanta	Wood frame, double pane	Furnace / AC	2790	kWh	34.3	MBtu	69.5	MBtu	--
3	GA Atlanta	with exterior clear panel	Furnace / AC	2640	kWh	31.3	MBtu	64.5	MBtu	7.2%
3	GA Atlanta	with interior clear panel	Furnace / AC	2674	kWh	30.3	MBtu	63.8	MBtu	8.2%
3	GA Atlanta	with exterior low-e panel	Furnace / AC	2512	kWh	29.3	MBtu	60.8	MBtu	**12.5%**
3	GA Atlanta	with interior low-e panel	Furnace / AC	2621	kWh	27.7	MBtu	60.3	MBtu	**13.2%**
3	GA Atlanta	with exterior solar-E panel	Furnace / AC	2251	kWh	31.6	MBtu	60.4	MBtu	**13.1%**
3	GA Atlanta	Metal frame, double pane	Furnace / AC	2729	kWh	39.6	MBtu	74.6	MBtu	--
3	GA Atlanta	with exterior clear panel	Furnace / AC	2685	kWh	33.2	MBtu	67.1	MBtu	10.0%
3	GA Atlanta	with interior clear panel	Furnace / AC	2657	kWh	32.4	MBtu	65.9	MBtu	11.7%
3	GA Atlanta	with exterior low-e panel	Furnace / AC	2558	kWh	30.3	MBtu	62.5	MBtu	**16.3%**
3	GA Atlanta	with interior low-e panel	Furnace / AC	2605	kWh	29.1	MBtu	61.7	MBtu	**17.3%**
3	GA Atlanta	with exterior solar-E panel	Furnace / AC	2285	kWh	32.8	MBtu	62.1	MBtu	**16.8%**
3	GA Atlanta	with exterior clear panel, worst case mounting	Furnace / AC	2644	kWh	35.8	MBtu	69.5	MBtu	6.9%
3	GA Atlanta	with exterior low-e panel, worst case mounting	Furnace / AC	2513	kWh	34.1	MBtu	66.1	MBtu	11.4%
3	GA Atlanta	with exterior solar-E panel, worst case mountin	Furnace / AC	2283	kWh	36.4	MBtu	66.0	MBtu	11.6%
3	TX Fort Worth	Wood frame, single pane	Furnace / AC	4607	kWh	33.7	MBtu	89.7	MBtu	--
3	TX Fort Worth	with exterior clear panel	Furnace / AC	4130	kWh	22.9	MBtu	72.4	MBtu	19.3%
3	TX Fort Worth	with interior clear panel	Furnace / AC	4112	kWh	22.3	MBtu	71.6	MBtu	20.2%
3	TX Fort Worth	with exterior low-e panel	Furnace / AC	3910	kWh	20.9	MBtu	67.7	MBtu	**24.5%**
3	TX Fort Worth	with interior low-e panel	Furnace / AC	3990	kWh	19.3	MBtu	66.9	MBtu	**25.4%**
3	TX Fort Worth	with exterior solar-E panel	Furnace / AC	3544	kWh	23.2	MBtu	66.0	MBtu	**26.4%**
3	TX Fort Worth	Wood frame, double pane	Furnace / AC	4304	kWh	25.2	MBtu	76.9	MBtu	--
3	TX Fort Worth	with exterior clear panel	Furnace / AC	4054	kWh	22.6	MBtu	71.2	MBtu	7.4%
3	TX Fort Worth	with interior clear panel	Furnace / AC	4091	kWh	21.8	MBtu	70.8	MBtu	8.0%
3	TX Fort Worth	with exterior low-e panel	Furnace / AC	3839	kWh	20.9	MBtu	66.9	MBtu	**13.0%**
3	TX Fort Worth	with interior low-e panel	Furnace / AC	3943	kWh	19.6	MBtu	66.7	MBtu	**13.3%**
3	TX Fort Worth	with exterior solar-E panel	Furnace / AC	3492	kWh	23.1	MBtu	65.3	MBtu	**15.1%**
3	TX Fort Worth	Metal frame, double pane	Furnace / AC	4285	kWh	29.7	MBtu	81.6	MBtu	--
3	TX Fort Worth	with exterior clear panel	Furnace / AC	4141	kWh	24.2	MBtu	74.0	MBtu	9.4%
3	TX Fort Worth	with interior clear panel	Furnace / AC	4086	kWh	23.5	MBtu	72.6	MBtu	11.1%
3	TX Fort Worth	with exterior low-e panel	Furnace / AC	3910	kWh	21.8	MBtu	68.7	MBtu	**15.8%**
3	TX Fort Worth	with interior low-e panel	Furnace / AC	3960	kWh	20.8	MBtu	68.2	MBtu	**16.5%**
3	TX Fort Worth	with exterior solar-E panel	Furnace / AC	3553	kWh	24.1	MBtu	67.1	MBtu	**17.8%**
3	TX Fort Worth	with exterior clear panel, worst case mounting	Furnace / AC	4112	kWh	26.4	MBtu	76.0	MBtu	6.8%
3	TX Fort Worth	with exterior low-e panel, worst case mounting	Furnace / AC	3892	kWh	25.1	MBtu	72.1	MBtu	11.7%
3	TX Fort Worth	with exterior solar-E panel, worst case mountin	Furnace / AC	3591	kWh	27.1	MBtu	70.8	MBtu	13.2%

Climate Zone	Location	Window	Cooling Cost ($)	Heating Cost ($)	Total Cost ($)	Energy cost savings	% energy cost savings	Simple payback	Payback for low-e
3	GA Atlanta	Wood frame, single pane	319.44	675.36	994.8	--	--	--	
3	GA Atlanta	with exterior clear panel	296.56	487.12	783.68	$211.12	21.2%	10.7	
3	GA Atlanta	with interior clear panel	295.79	476.15	771.94	$222.86	22.4%	10.1	
3	GA Atlanta	with exterior low-e panel	282.26	449.68	731.94	$262.86	**26.4%**	**9.6**	**4.9**
3	GA Atlanta	with interior low-e panel	293.15	421.31	714.46	$280.34	**28.2%**	**9.0**	**4.4**
3	GA Atlanta	with exterior solar-E panel	251.68	488.24	739.92	$254.88	**25.6%**	**9.9**	**5.8**
3	GA Atlanta	Wood frame, double pane	306.9	527.11	834.01	--	--	--	
3	GA Atlanta	with exterior clear panel	290.4	480.62	771.02	$62.99	7.6%	35.8	
3	GA Atlanta	with interior clear panel	294.14	466.45	760.59	$73.42	8.8%	30.7	
3	GA Atlanta	with exterior low-e panel	276.32	449.76	726.08	$107.93	**12.9%**	**23.3**	**5.7**
3	GA Atlanta	with interior low-e panel	288.31	425.38	713.69	$120.32	**14.4%**	**20.9**	**5.4**
3	GA Atlanta	with exterior solar-E panel	247.61	486.46	734.07	$99.94	**12.0%**	**25.1**	**6.9**
3	GA Atlanta	Metal frame, double pane	300.19	608.79	908.98	--	--	--	
3	GA Atlanta	with exterior clear panel	295.35	509.73	805.08	$103.90	11.4%	21.7	
3	GA Atlanta	with interior clear panel	292.27	497.33	789.6	$119.38	13.1%	18.9	
3	GA Atlanta	with exterior low-e panel	281.38	465.68	747.06	$161.92	**17.8%**	**15.5**	**4.4**
3	GA Atlanta	with interior low-e panel	286.55	447.59	734.14	$174.84	**19.2%**	**14.4**	**4.6**
3	GA Atlanta	with exterior solar-E panel	251.35	504.04	755.39	$153.59	**16.9%**	**16.4**	**5.1**
3	GA Atlanta	with exterior clear panel, worst case mounting	290.84	549.49	840.33	$68.65	7.6%	32.9	
3	GA Atlanta	with exterior low-e panel, worst case mounting	276.43	524.7	801.13	$107.85	11.9%	23.3	
3	GA Atlanta	with exterior solar-E panel, worst case mounting	251.13	558.9	810.03	$98.95	10.9%	25.4	
3	TX Fort Worth	Wood frame, single pane – Natural Gas Heating	506.77	358.7	865.47	--	--	--	
3	TX Fort Worth	with exterior clear panel	454.3	244.14	698.44	$167.03	19.3%	13.5	
3	TX Fort Worth	with interior clear panel	452.32	237.53	689.85	$175.62	20.3%	12.9	
3	TX Fort Worth	with exterior low-e panel	430.1	222.96	653.06	$212.41	**24.5%**	**11.8**	**5.6**
3	TX Fort Worth	with interior low-e panel	438.9	206.03	644.93	$220.54	**25.5%**	**11.4**	**5.7**
3	TX Fort Worth	with exterior solar-E panel	389.84	246.94	636.78	$228.69	**26.4%**	**11.0**	**4.1**
3	TX Fort Worth	Wood frame, double pane – Natural Gas Heating	473.44	267.89	741.33	--	--	--	
3	TX Fort Worth	with exterior clear panel	445.94	240.62	686.56	$54.77	7.4%	41.2	
3	TX Fort Worth	with interior clear panel	450.01	231.88	681.89	$59.44	8.0%	38.0	
3	TX Fort Worth	with exterior low-e panel	422.29	223.1	645.39	$95.94	**12.9%**	**26.2**	**6.2**
3	TX Fort Worth	with interior low-e panel	433.73	208.34	642.07	$99.26	**13.4%**	**25.3**	**6.4**
3	TX Fort Worth	with exterior solar-E panel	384.12	246.1	630.22	$111.11	**15.0%**	**22.6**	**4.5**
3	TX Fort Worth	Metal frame, double pane – Natural Gas Heating	471.35	316.65	788	--	--	--	
3	TX Fort Worth	with exterior clear panel	455.51	257.38	712.89	$75.11	9.5%	30.0	
3	TX Fort Worth	with interior clear panel	449.46	249.99	699.45	$88.55	11.2%	25.5	
3	TX Fort Worth	with exterior low-e panel	430.1	232.23	662.33	$125.67	**15.9%**	**20.0**	**5.0**
3	TX Fort Worth	with interior low-e panel	435.6	221.19	656.79	$131.21	**16.7%**	**19.1**	**6.0**
3	TX Fort Worth	with exterior solar-E panel	390.83	256.3	647.13	$140.87	**17.9%**	**17.8**	**3.9**
3	TX Fort Worth	with exterior clear panel, worst case mounting	452.32	281.01	733.33	$54.67	6.9%	41.3	
3	TX Fort Worth	with exterior low-e panel, worst case mounting	428.12	267.29	695.41	$92.59	11.8%	27.1	
3	TX Fort Worth	with exterior solar-E panel, worst case mounting	395.01	288.41	683.42	$104.58	13.3%	24.0	

Climate Zone	Location	Window	HVAC	Whole House Cooling		Whole House Heating		Source Energy		% source energy savings
3	TX Fort Worth	Wood frame, single pane	Heat pump / AC	4607	kWh	2857	kWh	85.7	MBtu	--
3	TX Fort Worth	with exterior clear panel	Heat pump / AC	4130	kWh	2115	kWh	71.7	MBtu	16.3%
3	TX Fort Worth	with interior clear panel	Heat pump / AC	4112	kWh	2074	kWh	71.0	MBtu	17.1%
3	TX Fort Worth	with exterior low-e panel	Heat pump / AC	3910	kWh	1970	kWh	67.5	MBtu	**21.2%**
3	TX Fort Worth	with interior low-e panel	Heat pump / AC	3990	kWh	1841	kWh	67.0	MBtu	**21.9%**
3	TX Fort Worth	with exterior solar-E panel	Heat pump / AC	3544	kWh	2123	kWh	65.1	MBtu	**24.1%**
3	TX Fort Worth	Wood frame, double pane	Heat pump / AC	4304	kWh	2279	kWh	75.6	MBtu	--
3	TX Fort Worth	with exterior clear panel	Heat pump / AC	4054	kWh	2087	kWh	70.5	MBtu	6.7%
3	TX Fort Worth	with interior clear panel	Heat pump / AC	4091	kWh	2037	kWh	70.4	MBtu	6.9%
3	TX Fort Worth	with exterior low-e panel	Heat pump / AC	3839	kWh	1970	kWh	66.7	MBtu	**11.8%**
3	TX Fort Worth	with interior low-e panel	Heat pump / AC	3943	kWh	1856	kWh	66.6	MBtu	**11.9%**
3	TX Fort Worth	with exterior solar-E panel	Heat pump / AC	3492	kWh	2117	kWh	64.4	MBtu	**14.8%**
3	TX Fort Worth	Metal frame, double pane	Heat pump / AC	4285	kWh	2569	kWh	78.7	MBtu	--
3	TX Fort Worth	with exterior clear panel	Heat pump / AC	4141	kWh	2202	kWh	72.8	MBtu	7.5%
3	TX Fort Worth	with interior clear panel	Heat pump / AC	4086	kWh	2152	kWh	71.6	MBtu	9.0%
3	TX Fort Worth	with exterior low-e panel	Heat pump / AC	3910	kWh	2032	kWh	68.2	MBtu	**13.3%**
3	TX Fort Worth	with interior low-e panel	Heat pump / AC	3960	kWh	1961	kWh	68.0	MBtu	**13.6%**
3	TX Fort Worth	with exterior solar-E panel	Heat pump / AC	3553	kWh	2186	kWh	65.9	MBtu	**16.3%**
3	TX Fort Worth	with exterior clear panel, worst case mounting	Heat pump / AC	4112	kWh	2345	kWh	74.1	MBtu	5.8%
3	TX Fort Worth	with exterior low-e panel, worst case mounting	Heat pump / AC	3892	kWh	2251	kWh	70.5	MBtu	10.4%
3	TX Fort Worth	with exterior solar-E panel, worst case mountin	Heat pump / AC	3591	kWh	2382	kWh	68.6	MBtu	12.9%
2	AZ Phoenix	Wood frame, single pane	Heat pump / AC	8512	kWh	1105	kWh	110.4	MBtu	--
2	AZ Phoenix	with exterior clear panel	Heat pump / AC	7591	kWh	791	kWh	96.2	MBtu	12.8%
2	AZ Phoenix	with interior clear panel	Heat pump / AC	7559	kWh	775	kWh	95.7	MBtu	13.3%
2	AZ Phoenix	with exterior low-e panel	Heat pump / AC	7157	kWh	724	kWh	90.5	MBtu	**18.1%**
2	AZ Phoenix	with interior low-e panel	Heat pump / AC	7295	kWh	677	kWh	91.5	MBtu	**17.1%**
2	AZ Phoenix	with exterior solar-E panel	Heat pump / AC	6634	kWh	800	kWh	85.4	MBtu	**22.7%**
2	AZ Phoenix	Wood frame, double pane	Heat pump / AC	7903	kWh	860	kWh	100.6	MBtu	--
2	AZ Phoenix	with exterior clear panel	Heat pump / AC	7470	kWh	782	kWh	94.7	MBtu	5.8%
2	AZ Phoenix	with interior clear panel	Heat pump / AC	7516	kWh	756	kWh	95.0	MBtu	5.6%
2	AZ Phoenix	with exterior low-e panel	Heat pump / AC	7042	kWh	725	kWh	89.2	MBtu	**11.4%**
2	AZ Phoenix	with interior low-e panel	Heat pump / AC	7225	kWh	685	kWh	90.8	MBtu	**9.7%**
2	AZ Phoenix	with exterior solar-E panel	Heat pump / AC	6549	kWh	799	kWh	84.4	MBtu	**16.1%**
2	AZ Phoenix	Metal frame, double pane	Heat pump / AC	8016	kWh	1002	kWh	103.5	MBtu	--
2	AZ Phoenix	with exterior clear panel	Heat pump / AC	7669	kWh	834	kWh	97.6	MBtu	5.7%
2	AZ Phoenix	with interior clear panel	Heat pump / AC	7571	kWh	813	kWh	96.3	MBtu	7.0%
2	AZ Phoenix	with exterior low-e panel	Heat pump / AC	7191	kWh	752	kWh	91.2	MBtu	**11.9%**
2	AZ Phoenix	with interior low-e panel	Heat pump / AC	7249	kWh	722	kWh	91.5	MBtu	**11.6%**
2	AZ Phoenix	with exterior solar-E panel	Heat pump / AC	6679	kWh	834	kWh	86.3	MBtu	**16.7%**
2	AZ Phoenix	with exterior clear panel, worst case mounting	Heat pump / AC	7691	kWh	905	kWh	98.7	MBtu	4.7%
2	AZ Phoenix	with exterior low-e panel, worst case mounting	Heat pump / AC	7277	kWh	858	kWh	93.4	MBtu	9.8%
2	AZ Phoenix	with exterior solar-E panel, worst case mountin	Heat pump / AC	6841	kWh	929	kWh	89.2	MBtu	13.8%

Climate Zone	Location	Window	Cooling Cost ($)	Heating Cost ($)	Total Cost ($)	Energy cost savings	% energy cost savings	Simple payback	Payback for low-e
3	TX Fort Worth	Wood frame, single pane – Heat Pump Heating	506.77	314.27	821.04	--	--	--	
3	TX Fort Worth	with exterior clear panel	454.3	232.65	686.95	$134.09	16.3%	16.8	
3	TX Fort Worth	with interior clear panel	452.32	228.14	680.46	$140.58	17.1%	16.1	
3	TX Fort Worth	with exterior low-e panel	430.1	216.7	646.8	$174.24	**21.2%**	**14.4**	**6.4**
3	TX Fort Worth	with interior low-e panel	438.9	202.51	641.41	$179.63	**21.9%**	**14.0**	**6.5**
3	TX Fort Worth	with exterior solar-E panel	389.84	233.53	623.37	$197.67	**24.1%**	**12.7**	**4.0**
3	TX Fort Worth	Wood frame, double pane – Heat Pump Heating	473.44	250.69	724.13	--	--	--	
3	TX Fort Worth	with exterior clear panel	445.94	229.57	675.51	$48.62	6.7%	46.4	
3	TX Fort Worth	with interior clear panel	450.01	224.07	674.08	$50.05	6.9%	45.1	
3	TX Fort Worth	with exterior low-e panel	422.29	216.7	638.99	$85.14	**11.8%**	**29.5**	**7.0**
3	TX Fort Worth	with interior low-e panel	433.73	204.16	637.89	$86.24	**11.9%**	**29.1**	**7.0**
3	TX Fort Worth	with exterior solar-E panel	384.12	232.87	616.99	$107.14	**14.8%**	**23.4**	**4.4**
3	TX Fort Worth	Metal frame, double pane – Heat Pump Heating	471.35	282.59	753.94	--	--	--	
3	TX Fort Worth	with exterior clear panel	455.51	242.22	697.73	$56.21	7.5%	40.1	
3	TX Fort Worth	with interior clear panel	449.46	236.72	686.18	$67.76	9.0%	33.3	
3	TX Fort Worth	with exterior low-e panel	430.1	223.52	653.62	$100.32	**13.3%**	**25.0**	**5.8**
3	TX Fort Worth	with interior low-e panel	435.6	215.71	651.31	$102.63	**13.6%**	**24.5**	**7.3**
3	TX Fort Worth	with exterior solar-E panel	390.83	240.46	631.29	$122.65	**16.3%**	**20.5**	**3.8**
3	TX Fort Worth	with exterior clear panel, worst case mounting	452.32	257.95	710.27	$43.67	5.8%	51.7	
3	TX Fort Worth	with exterior low-e panel, worst case mounting	428.12	247.61	675.73	$78.21	10.4%	32.1	
3	TX Fort Worth	with exterior solar-E panel, worst case mounting	395.01	262.02	657.03	$96.91	12.9%	25.9	
2	AZ Phoenix	Wood frame, single pane	961.86	124.86	1086.72	--	--	--	
2	AZ Phoenix	with exterior clear panel	857.78	89.38	947.16	$139.56	12.8%	16.2	
2	AZ Phoenix	with interior clear panel	854.17	87.57	941.74	$144.98	13.3%	15.6	
2	AZ Phoenix	with exterior low-e panel	808.74	81.81	890.55	$196.17	**18.1%**	**12.8**	**4.5**
2	AZ Phoenix	with interior low-e panel	824.33	76.5	900.83	$185.89	**17.1%**	**13.5**	**6.2**
2	AZ Phoenix	with exterior solar-E panel	749.64	90.4	840.04	$246.68	**22.7%**	**10.2**	**2.4**
2	AZ Phoenix	Wood frame, double pane	893.04	97.18	990.22	--	--	--	
2	AZ Phoenix	with exterior clear panel	844.11	88.37	932.48	$57.74	5.8%	39.1	
2	AZ Phoenix	with interior clear panel	849.31	85.43	934.74	$55.48	5.6%	40.7	
2	AZ Phoenix	with exterior low-e panel	795.75	81.92	877.67	$112.55	**11.4%**	**22.3**	**4.7**
2	AZ Phoenix	with interior low-e panel	816.42	77.4	893.82	$96.40	**9.7%**	**26.1**	**6.2**
2	AZ Phoenix	with exterior solar-E panel	740.04	90.29	830.33	$159.89	**16.1%**	**15.7**	**2.5**
2	AZ Phoenix	Metal frame, double pane	905.81	113.23	1019.04	--	--	--	
2	AZ Phoenix	with exterior clear panel	866.6	94.24	960.84	$58.20	5.7%	38.8	
2	AZ Phoenix	with interior clear panel	855.52	91.87	947.39	$71.65	7.0%	31.5	
2	AZ Phoenix	with exterior low-e panel	812.58	84.98	897.56	$121.48	**11.9%**	**20.7**	**4.0**
2	AZ Phoenix	with interior low-e panel	819.14	81.59	900.73	$118.31	**11.6%**	**21.2**	**5.5**
2	AZ Phoenix	with exterior solar-E panel	754.73	94.24	848.97	$170.07	**16.7%**	**14.8**	**2.3**
2	AZ Phoenix	with exterior clear panel, worst case mounting	869.08	102.26	971.34	$47.70	4.7%	47.3	
2	AZ Phoenix	with exterior low-e panel, worst case mounting	822.3	96.95	919.25	$99.79	9.8%	25.2	
2	AZ Phoenix	with exterior solar-E panel, worst case mounting	773.03	104.98	878.01	$141.03	13.8%	17.8	

Climate Zone	Location	Window	HVAC	Whole House Cooling		Whole House Heating		Source Energy		% source energy savings
2	FL Jacksonville	Wood frame, single pane	Heat pump / AC	4829	kWh	1635	kWh	74.2	MBtu	--
2	FL Jacksonville	with exterior clear panel	Heat pump / AC	4379	kWh	1207	kWh	64.1	MBtu	13.6%
2	FL Jacksonville	with interior clear panel	Heat pump / AC	4363	kWh	1184	kWh	63.7	MBtu	14.2%
2	FL Jacksonville	with exterior low-e panel	Heat pump / AC	4171	kWh	1122	kWh	60.8	MBtu	**18.1%**
2	FL Jacksonville	with interior low-e panel	Heat pump / AC	4304	kWh	1053	kWh	61.5	MBtu	**17.1%**
2	FL Jacksonville	with exterior solar-E panel	Heat pump / AC	3782	kWh	1223	kWh	57.5	MBtu	**22.6%**
2	FL Jacksonville	Wood frame, double pane	Heat pump / AC	4553	kWh	1301	kWh	67.2	MBtu	--
2	FL Jacksonville	with exterior clear panel	Heat pump / AC	4300	kWh	1195	kWh	63.1	MBtu	6.1%
2	FL Jacksonville	with interior clear panel	Heat pump / AC	4338	kWh	1163	kWh	63.2	MBtu	6.0%
2	FL Jacksonville	with exterior low-e panel	Heat pump / AC	4101	kWh	1123	kWh	60.0	MBtu	**10.8%**
2	FL Jacksonville	with interior low-e panel	Heat pump / AC	4248	kWh	1065	kWh	61.0	MBtu	**9.2%**
2	FL Jacksonville	with exterior solar-E panel	Heat pump / AC	3731	kWh	1221	kWh	56.9	MBtu	**15.4%**
2	FL Jacksonville	Metal frame, double pane	Heat pump / AC	4491	kWh	1487	kWh	68.6	MBtu	--
2	FL Jacksonville	with exterior clear panel	Heat pump / AC	4375	kWh	1264	kWh	64.7	MBtu	5.7%
2	FL Jacksonville	with interior clear panel	Heat pump / AC	4324	kWh	1235	kWh	63.8	MBtu	7.0%
2	FL Jacksonville	with exterior low-e panel	Heat pump / AC	4168	kWh	1162	kWh	61.2	MBtu	**10.8%**
2	FL Jacksonville	with interior low-e panel	Heat pump / AC	4224	kWh	1116	kWh	61.3	MBtu	**10.7%**
2	FL Jacksonville	with exterior solar-E panel	Heat pump / AC	3783	kWh	1262	kWh	57.9	MBtu	**15.6%**
2	FL Jacksonville	with exterior clear panel, worst case mounting	Heat pump / AC	4327	kWh	1353	kWh	65.2	MBtu	5.0%
2	FL Jacksonville	with exterior low-e panel, worst case mounting	Heat pump / AC	4127	kWh	1297	kWh	62.3	MBtu	9.3%
2	FL Jacksonville	with exterior solar-E panel, worst case mountin	Heat pump / AC	3805	kWh	1384	kWh	59.6	MBtu	13.2%
2	TX Houston	Wood frame, single pane	Furnace / AC	4945	kWh	21.4	MBtu	80.1	MBtu	--
2	TX Houston	with exterior clear panel	Furnace / AC	4459	kWh	14.4	MBtu	66.9	MBtu	16.5%
2	TX Houston	with interior clear panel	Furnace / AC	4437	kWh	14	MBtu	66.2	MBtu	17.4%
2	TX Houston	with exterior low-e panel	Furnace / AC	4245	kWh	13	MBtu	62.9	MBtu	**21.5%**
2	TX Houston	with interior low-e panel	Furnace / AC	4371	kWh	12	MBtu	63.3	MBtu	**21.0%**
2	TX Houston	with exterior solar-E panel	Furnace / AC	3839	kWh	14.3	MBtu	59.7	MBtu	**25.5%**
2	TX Houston	Wood frame, double pane	Furnace / AC	4646	kWh	15.9	MBtu	70.7	MBtu	--
2	TX Houston	with exterior clear panel	Furnace / AC	4378	kWh	14.2	MBtu	65.8	MBtu	7.0%
2	TX Houston	with interior clear panel	Furnace / AC	4415	kWh	13.7	MBtu	65.7	MBtu	7.1%
2	TX Houston	with exterior low-e panel	Furnace / AC	4164	kWh	13	MBtu	62.0	MBtu	**12.3%**
2	TX Houston	with interior low-e panel	Furnace / AC	4317	kWh	12.2	MBtu	62.9	MBtu	**11.1%**
2	TX Houston	with exterior solar-E panel	Furnace / AC	3783	kWh	14.2	MBtu	58.9	MBtu	**16.6%**
2	TX Houston	Metal frame, double pane	Furnace / AC	4589	kWh	18.8	MBtu	73.2	MBtu	--
2	TX Houston	with exterior clear panel	Furnace / AC	4457	kWh	15.2	MBtu	67.8	MBtu	7.4%
2	TX Houston	with interior clear panel	Furnace / AC	4401	kWh	14.7	MBtu	66.6	MBtu	9.1%
2	TX Houston	with exterior low-e panel	Furnace / AC	4237	kWh	13.6	MBtu	63.5	MBtu	**13.3%**
2	TX Houston	with interior low-e panel	Furnace / AC	4290	kWh	12.9	MBtu	63.3	MBtu	**13.5%**
2	TX Houston	with exterior solar-E panel	Furnace / AC	3840	kWh	14.9	MBtu	60.4	MBtu	**17.6%**
2	TX Houston	with exterior clear panel, worst case mounting	Furnace / AC	4412	kWh	16.6	MBtu	68.8	MBtu	6.1%
2	TX Houston	with exterior low-e panel, worst case mounting	Furnace / AC	4197	kWh	15.7	MBtu	65.3	MBtu	10.8%
2	TX Houston	with exterior solar-E panel, worst case mountin	Furnace / AC	3863	kWh	16.8	MBtu	62.7	MBtu	14.4%

Climate Zone	Location	Window	Cooling Cost ($)	Heating Cost ($)	Total Cost ($)	Energy cost savings	% energy cost savings	Simple payback	Payback for low-e
2	FL Jacksonville	Wood frame, single pane	555.34	188.03	743.37	--	--	--	
2	FL Jacksonville	with exterior clear panel	503.59	138.81	642.4	$100.97	13.6%	22.4	
2	FL Jacksonville	with interior clear panel	501.75	136.16	637.91	$105.46	14.2%	21.4	
2	FL Jacksonville	with exterior low-e panel	479.67	129.03	608.7	$134.67	**18.1%**	**18.7**	**7.6**
2	FL Jacksonville	with interior low-e panel	494.96	121.1	616.06	$127.31	**17.1%**	**19.7**	**11.7**
2	FL Jacksonville	with exterior solar-E panel	434.93	140.65	575.58	$167.79	**22.6%**	**15.0**	**3.8**
2	FL Jacksonville	Wood frame, double pane	523.6	149.62	673.22	--	--	--	
2	FL Jacksonville	with exterior clear panel	494.5	137.43	631.93	$41.29	6.1%	54.7	
2	FL Jacksonville	with interior clear panel	498.87	133.75	632.62	$40.60	6.0%	55.6	
2	FL Jacksonville	with exterior low-e panel	471.62	129.15	600.77	$72.45	**10.8%**	**34.7**	**8.2**
2	FL Jacksonville	with interior low-e panel	488.52	122.48	611	$62.22	**9.2%**	**40.4**	**11.8**
2	FL Jacksonville	with exterior solar-E panel	429.07	140.42	569.49	$103.73	**15.4%**	**24.2**	**4.1**
2	FL Jacksonville	Metal frame, double pane	516.47	171.01	687.48	--	--	--	
2	FL Jacksonville	with exterior clear panel	503.13	145.36	648.49	$38.99	5.7%	57.9	
2	FL Jacksonville	with interior clear panel	497.26	142.03	639.29	$48.19	7.0%	46.8	
2	FL Jacksonville	with exterior low-e panel	479.32	133.63	612.95	$74.53	**10.8%**	**33.7**	**7.2**
2	FL Jacksonville	with interior low-e panel	485.76	128.34	614.1	$73.38	**10.7%**	**34.2**	**10.1**
2	FL Jacksonville	with exterior solar-E panel	435.05	145.13	580.18	$107.30	**15.6%**	**23.4**	**3.7**
2	FL Jacksonville	with exterior clear panel, worst case mounting	497.61	155.6	653.21	$34.27	5.0%	65.9	
2	FL Jacksonville	with exterior low-e panel, worst case mounting	474.61	149.16	623.77	$63.71	9.3%	39.4	
2	FL Jacksonville	with exterior solar-E panel, worst case mounting	437.58	159.16	596.74	$90.74	13.2%	27.7	
2	TX Houston	Wood frame, single pane – Natural Gas Heating	543.95	227.43	771.38	--	--	--	
2	TX Houston	with exterior clear panel	490.49	153.73	644.22	$127.16	16.5%	17.7	
2	TX Houston	with interior clear panel	488.07	149.55	637.62	$133.76	17.3%	16.9	
2	TX Houston	with exterior low-e panel	466.95	138.59	605.54	$165.84	**21.5%**	**15.1**	**6.6**
2	TX Houston	with interior low-e panel	480.81	128.25	609.06	$162.32	**21.0%**	**15.5**	**8.9**
2	TX Houston	with exterior solar-E panel	422.29	152.43	574.72	$196.66	**25.5%**	**12.8**	**3.7**
2	TX Houston	Wood frame, double pane – Natural Gas Heating	511.06	169.43	680.49	--	--	--	
2	TX Houston	with exterior clear panel	481.58	150.85	632.43	$48.06	7.1%	47.0	
2	TX Houston	with interior clear panel	485.65	145.65	631.3	$49.19	7.2%	45.9	
2	TX Houston	with exterior low-e panel	458.04	138.46	596.5	$83.99	**12.3%**	**29.9**	**7.1**
2	TX Houston	with interior low-e panel	474.87	129.51	604.38	$76.11	**11.2%**	**33.0**	**9.5**
2	TX Houston	with exterior solar-E panel	416.13	151.47	567.6	$112.89	**16.6%**	**22.2**	**3.9**
2	TX Houston	Metal frame, double pane – Natural Gas Heating	504.79	200.2	704.99	--	--	--	
2	TX Houston	with exterior clear panel	490.27	162	652.27	$52.72	7.5%	42.8	
2	TX Houston	with interior clear panel	484.11	157.08	641.19	$63.80	9.0%	35.4	
2	TX Houston	with exterior low-e panel	466.07	144.66	610.73	$94.26	**13.4%**	**26.6**	**6.1**
2	TX Houston	with interior low-e panel	471.9	137.74	609.64	$95.35	**13.5%**	**26.3**	**8.1**
2	TX Houston	with exterior solar-E panel	422.4	158.25	580.65	$124.34	**17.6%**	**20.2**	**3.6**
2	TX Houston	with exterior clear panel, worst case mounting	485.32	176.73	662.05	$42.94	6.1%	52.6	
2	TX Houston	with exterior low-e panel, worst case mounting	461.67	166.78	628.45	$76.54	10.9%	32.8	
2	TX Houston	with exterior solar-E panel, worst case mounting	424.93	179.02	603.95	$101.04	14.3%	24.9	

Climate Zone	Location	Window	HVAC	Whole House Cooling		Whole House Heating		Source Energy		% source energy savings
2	TX Houston	Wood frame, single pane	Heat pump / AC	4945	kWh	1913	kWh	78.7	MBtu	--
2	TX Houston	with exterior clear panel	Heat pump / AC	4459	kWh	1420	kWh	67.5	MBtu	14.3%
2	TX Houston	with interior clear panel	Heat pump / AC	4437	kWh	1396	kWh	67.0	MBtu	14.9%
2	TX Houston	with exterior low-e panel	Heat pump / AC	4245	kWh	1313	kWh	63.8	MBtu	**19.0%**
2	TX Houston	with interior low-e panel	Heat pump / AC	4371	kWh	1243	kWh	64.5	MBtu	**18.1%**
2	TX Houston	with exterior solar-E panel	Heat pump / AC	3839	kWh	1404	kWh	60.2	MBtu	**23.5%**
2	TX Houston	Wood frame, double pane	Heat pump / AC	4646	kWh	1530	kWh	70.9	MBtu	--
2	TX Houston	with exterior clear panel	Heat pump / AC	4378	kWh	1397	kWh	66.3	MBtu	6.5%
2	TX Houston	with interior clear panel	Heat pump / AC	4415	kWh	1368	kWh	66.4	MBtu	6.4%
2	TX Houston	with exterior low-e panel	Heat pump / AC	4165	kWh	1311	kWh	62.9	MBtu	**11.3%**
2	TX Houston	with interior low-e panel	Heat pump / AC	4317	kWh	1252	kWh	63.9	MBtu	**9.8%**
2	TX Houston	with exterior solar-E panel	Heat pump / AC	3783	kWh	1397	kWh	59.5	MBtu	**16.1%**
2	TX Houston	Metal frame, double pane	Heat pump / AC	4589	kWh	1723	kWh	72.5	MBtu	--
2	TX Houston	with exterior clear panel	Heat pump / AC	4457	kWh	1475	kWh	68.1	MBtu	6.0%
2	TX Houston	with interior clear panel	Heat pump / AC	4401	kWh	1440	kWh	67.1	MBtu	7.5%
2	TX Houston	with exterior low-e panel	Heat pump / AC	4237	kWh	1356	kWh	64.2	MBtu	**11.4%**
2	TX Houston	with interior low-e panel	Heat pump / AC	4290	kWh	1307	kWh	64.3	MBtu	**11.3%**
2	TX Houston	with exterior solar-E panel	Heat pump / AC	3840	kWh	1443	kWh	60.7	MBtu	**16.3%**
2	TX Houston	with exterior clear panel, worst case mounting	Heat pump / AC	4412	kWh	1568	kWh	68.7	MBtu	5.3%
2	TX Houston	with exterior low-e panel, worst case mounting	Heat pump / AC	4197	kWh	1497	kWh	65.4	MBtu	9.8%
2	TX Houston	with exterior solar-E panel, worst case mountin	Heat pump / AC	3863	kWh	1576	kWh	62.4	MBtu	13.8%
1	FL Miami	Wood frame, single pane	Heat pump / AC	7601	kWh	79	kWh	88.2	MBtu	--
1	FL Miami	with exterior clear panel	Heat pump / AC	6920	kWh	43	kWh	79.9	MBtu	9.3%
1	FL Miami	with interior clear panel	Heat pump / AC	6890	kWh	41	kWh	79.6	MBtu	9.8%
1	FL Miami	with exterior low-e panel	Heat pump / AC	6625	kWh	36	kWh	76.5	MBtu	**13.3%**
1	FL Miami	with interior low-e panel	Heat pump / AC	6797	kWh	32	kWh	78.4	MBtu	**11.1%**
1	FL Miami	with exterior solar-E panel	Heat pump / AC	6051	kWh	41	kWh	69.9	MBtu	**20.7%**
1	FL Miami	Wood frame, double pane	Heat pump / AC	7193	kWh	50	kWh	83.2	MBtu	--
1	FL Miami	with exterior clear panel	Heat pump / AC	6813	kWh	42	kWh	78.7	MBtu	5.4%
1	FL Miami	with interior clear panel	Heat pump / AC	6862	kWh	40	kWh	79.2	MBtu	4.7%
1	FL Miami	with exterior low-e panel	Heat pump / AC	6517	kWh	35	kWh	75.2	MBtu	**9.5%**
1	FL Miami	with interior low-e panel	Heat pump / AC	6724	kWh	33	kWh	77.6	MBtu	**6.7%**
1	FL Miami	with exterior solar-E panel	Heat pump / AC	5972	kWh	41	kWh	69.0	MBtu	**17.0%**
1	FL Miami	Metal frame, double pane	Heat pump / AC	7100	kWh	65	kWh	82.3	MBtu	--
1	FL Miami	with exterior clear panel	Heat pump / AC	6921	kWh	47	kWh	80.0	MBtu	2.7%
1	FL Miami	with interior clear panel	Heat pump / AC	6842	kWh	44	kWh	79.1	MBtu	3.9%
1	FL Miami	with exterior low-e panel	Heat pump / AC	6613	kWh	38	kWh	76.4	MBtu	**7.2%**
1	FL Miami	with interior low-e panel	Heat pump / AC	6690	kWh	36	kWh	77.2	MBtu	**6.1%**
1	FL Miami	with exterior solar-E panel	Heat pump / AC	6052	kWh	44	kWh	70.0	MBtu	**14.9%**
1	FL Miami	with exterior clear panel, worst case mounting	Heat pump / AC	6855	kWh	54	kWh	79.3	MBtu	3.6%
1	FL Miami	with exterior low-e panel, worst case mounting	Heat pump / AC	6554	kWh	48	kWh	75.8	MBtu	7.9%
1	FL Miami	with exterior solar-E panel, worst case mountin	Heat pump / AC	6068	kWh	55	kWh	70.3	MBtu	14.5%

Climate Zone	Location	Window	Cooling Cost ($)	Heating Cost ($)	Total Cost ($)	Energy cost savings	% energy cost savings	Simple payback	Payback for low-e
2	TX Houston	Wood frame, single pane – Heat Pump Heating	543.95	210.43	754.38	--	--	--	
2	TX Houston	with exterior clear panel	490.49	156.2	646.69	$107.69	14.3%	21.0	
2	TX Houston	with interior clear panel	488.07	153.56	641.63	$112.75	14.9%	20.0	
2	TX Houston	with exterior low-e panel	466.95	144.43	611.38	$143.00	**19.0%**	**17.6**	**7.2**
2	TX Houston	with interior low-e panel	480.81	136.73	617.54	$136.84	**18.1%**	**18.4**	**10.6**
2	TX Houston	with exterior solar-E panel	422.29	154.44	576.73	$177.65	**23.5%**	**14.1**	**3.6**
2	TX Houston	Wood frame, double pane – Heat Pump Heating	511.06	168.3	679.36	--	--	--	
2	TX Houston	with exterior clear panel	481.58	153.67	635.25	$44.11	6.5%	51.2	
2	TX Houston	with interior clear panel	485.65	150.48	636.13	$43.23	6.4%	52.2	
2	TX Houston	with exterior low-e panel	458.15	144.21	602.36	$77.00	**11.3%**	**32.6**	**7.8**
2	TX Houston	with interior low-e panel	474.87	137.72	612.59	$66.77	**9.8%**	**37.6**	**10.8**
2	TX Houston	with exterior solar-E panel	416.13	153.67	569.8	$109.56	**16.1%**	**22.9**	**3.9**
2	TX Houston	Metal frame, double pane – Heat Pump Heating	504.79	189.53	694.32	--	--	--	
2	TX Houston	with exterior clear panel	490.27	162.25	652.52	$41.80	6.0%	54.0	
2	TX Houston	with interior clear panel	484.11	158.4	642.51	$51.81	7.5%	43.6	
2	TX Houston	with exterior low-e panel	466.07	149.16	615.23	$79.09	**11.4%**	**31.8**	**6.8**
2	TX Houston	with interior low-e panel	471.9	143.77	615.67	$78.65	**11.3%**	**31.9**	**9.5**
2	TX Houston	with exterior solar-E panel	422.4	158.73	581.13	$113.19	**16.3%**	**22.2**	**3.6**
2	TX Houston	with exterior clear panel, worst case mounting	485.32	172.48	657.8	$36.52	5.3%	61.8	
2	TX Houston	with exterior low-e panel, worst case mounting	461.67	164.67	626.34	$67.98	9.8%	36.9	
2	TX Houston	with exterior solar-E panel, worst case mounting	424.93	173.36	598.29	$96.03	13.8%	26.2	
1	FL Miami	Wood frame, single pane	874.12	9.09	883.21	--	--	--	
1	FL Miami	with exterior clear panel	795.8	4.95	800.75	$82.46	9.3%	27.4	
1	FL Miami	with interior clear panel	792.35	4.72	797.07	$86.14	9.8%	26.2	
1	FL Miami	with exterior low-e panel	761.88	4.14	766.02	$117.19	**13.3%**	**21.4**	**7.3**
1	FL Miami	with interior low-e panel	781.66	3.68	785.34	$97.87	**11.1%**	**25.7**	**21.7**
1	FL Miami	with exterior solar-E panel	695.87	4.72	700.59	$182.62	**20.7%**	**13.8**	**2.5**
1	FL Miami	Wood frame, double pane	827.2	5.75	832.95	--	--	--	
1	FL Miami	with exterior clear panel	783.5	4.83	788.33	$44.62	5.4%	50.6	
1	FL Miami	with interior clear panel	789.13	4.6	793.73	$39.22	4.7%	57.5	
1	FL Miami	with exterior low-e panel	749.46	4.03	753.49	$79.46	**9.5%**	**31.6**	**7.3**
1	FL Miami	with interior low-e panel	773.26	3.8	777.06	$55.89	**6.7%**	**44.9**	**15.3**
1	FL Miami	with exterior solar-E panel	686.78	4.72	691.5	$141.45	**17.0%**	**17.8**	**2.6**
1	FL Miami	Metal frame, double pane	816.5	7.48	823.98	--	--	--	
1	FL Miami	with exterior clear panel	795.92	5.41	801.33	$22.65	2.7%	99.6	
1	FL Miami	with interior clear panel	786.83	5.06	791.89	$32.09	3.9%	70.3	
1	FL Miami	with exterior low-e panel	760.5	4.37	764.87	$59.11	**7.2%**	**42.5**	**7.0**
1	FL Miami	with interior low-e panel	769.35	4.14	773.49	$50.49	**6.1%**	**49.7**	**13.9**
1	FL Miami	with exterior solar-E panel	695.98	5.06	701.04	$122.94	**14.9%**	**20.4**	**2.5**
1	FL Miami	with exterior clear panel, worst case mounting	788.33	6.21	794.54	$29.44	3.6%	76.7	
1	FL Miami	with exterior low-e panel, worst case mounting	753.71	5.52	759.23	$64.75	7.9%	38.8	
1	FL Miami	with exterior solar-E panel, worst case mounting	697.82	6.33	704.15	$119.83	14.5%	21.0	

Larger, Newer Home (2-story, 2800 ft^2)

Climate Zone	Location	Window	HVAC	Whole House Cooling		Whole House Heating		Source Energy		% source energy savings
8	AK Fairbanks	Wood frame, single pane	Furnace / AC	137	kWh	247.8	MBtu	272.2	MBtu	--
8	AK Fairbanks	with exterior clear panel	Furnace / AC	117	kWh	166.7	MBtu	183.4	MBtu	32.6%
8	AK Fairbanks	with interior clear panel	Furnace / AC	119	kWh	162.2	MBtu	178.5	MBtu	34.4%
8	AK Fairbanks	with exterior low-e panel	Furnace / AC	98	kWh	149.1	MBtu	163.9	MBtu	**39.8%**
8	AK Fairbanks	with interior low-e panel	Furnace / AC	113	kWh	141.2	MBtu	155.5	MBtu	**42.9%**
8	AK Fairbanks	Wood frame, double pane	Furnace / AC	129	kWh	185.7	MBtu	204.3	MBtu	--
8	AK Fairbanks	with exterior clear panel	Furnace / AC	108	kWh	160.8	MBtu	176.8	MBtu	13.4%
8	AK Fairbanks	with interior clear panel	Furnace / AC	115	kWh	156.2	MBtu	171.9	MBtu	15.8%
8	AK Fairbanks	with exterior low-e panel	Furnace / AC	90	kWh	146.8	MBtu	161.3	MBtu	**21.0%**
8	AK Fairbanks	with interior low-e panel	Furnace / AC	106	kWh	141	MBtu	155.2	MBtu	**24.0%**
8	AK Fairbanks	Metal frame, double pane	Furnace / AC	118	kWh	212.5	MBtu	233.4	MBtu	--
8	AK Fairbanks	with exterior clear panel	Furnace / AC	112	kWh	172.6	MBtu	189.8	MBtu	18.7%
8	AK Fairbanks	with interior clear panel	Furnace / AC	110	kWh	167.2	MBtu	183.8	MBtu	21.2%
8	AK Fairbanks	with exterior low-e panel	Furnace / AC	95	kWh	153.9	MBtu	169.1	MBtu	**27.5%**
8	AK Fairbanks	with interior low-e panel	Furnace / AC	102	kWh	148.7	MBtu	163.6	MBtu	**29.9%**
8	AK Fairbanks	with exterior clear panel, worst case mounting	Furnace / AC	108	kWh	185.7	MBtu	204.0	MBtu	12.6%
8	AK Fairbanks	with exterior low-e panel, worst case mounting	Furnace / AC	92	kWh	173.9	MBtu	191.0	MBtu	18.2%
7	AK Anchorage	Wood frame, single pane	Furnace / AC	24	kWh	166.7	MBtu	182.3	MBtu	--
7	AK Anchorage	with exterior clear panel	Furnace / AC	18	kWh	105.8	MBtu	115.7	MBtu	36.5%
7	AK Anchorage	with interior clear panel	Furnace / AC	22	kWh	102.7	MBtu	112.4	MBtu	38.3%
7	AK Anchorage	with exterior low-e panel	Furnace / AC	14	kWh	92.2	MBtu	100.8	MBtu	**44.7%**
7	AK Anchorage	with interior low-e panel	Furnace / AC	19	kWh	86.5	MBtu	94.7	MBtu	**48.1%**
7	AK Anchorage	Wood frame, double pane	Furnace / AC	24	kWh	119.6	MBtu	130.9	MBtu	--
7	AK Anchorage	with exterior clear panel	Furnace / AC	16	kWh	101.9	MBtu	111.5	MBtu	14.8%
7	AK Anchorage	with interior clear panel	Furnace / AC	19	kWh	98.7	MBtu	108.0	MBtu	17.5%
7	AK Anchorage	with exterior low-e panel	Furnace / AC	14	kWh	90.7	MBtu	99.2	MBtu	**24.2%**
7	AK Anchorage	with interior low-e panel	Furnace / AC	16	kWh	86.5	MBtu	94.6	MBtu	**27.7%**
7	AK Anchorage	Metal frame, double pane	Furnace / AC	17	kWh	141.3	MBtu	154.5	MBtu	--
7	AK Anchorage	with exterior clear panel	Furnace / AC	17	kWh	111	MBtu	121.4	MBtu	21.4%
7	AK Anchorage	with interior clear panel	Furnace / AC	16	kWh	106.9	MBtu	116.9	MBtu	24.3%
7	AK Anchorage	with exterior low-e panel	Furnace / AC	14	kWh	96	MBtu	105.0	MBtu	**32.0%**
7	AK Anchorage	with interior low-e panel	Furnace / AC	15	kWh	92.2	MBtu	100.9	MBtu	**34.7%**
7	AK Anchorage	with exterior clear panel, worst case mounting	Furnace / AC	16	kWh	121.4	MBtu	132.8	MBtu	14.1%
7	AK Anchorage	with exterior low-e panel, worst case mounting	Furnace / AC	12	kWh	111.8	MBtu	122.2	MBtu	20.9%

Climate Zone	Location	Window	Cooling Cost ($)	Heating Cost ($)	Total Cost ($)	Energy cost savings	% energy cost savings	Simple payback	Payback for low-e
8	AK Fairbanks	Wood frame, single pane	12.82	2051.88	2076.27	--	--	--	
8	AK Fairbanks	with exterior clear panel	10.5	1380.33	1401.16	$675.11	32.5%	5.5	
8	AK Fairbanks	with interior clear panel	10.5	1342.88	1364.06	$712.21	34.3%	5.2	
8	AK Fairbanks	with exterior low-e panel	8.01	1234.92	1252.36	$823.91	**39.7%**	**5.0**	**2.8**
8	AK Fairbanks	with interior low-e panel	9.97	1168.9	1189.01	$887.26	**42.7%**	**4.7**	**2.4**
8	AK Fairbanks	Wood frame, double pane	11.75	1537.83	1560.79	--	--	--	
8	AK Fairbanks	with exterior clear panel	9.43	1331.07	1350.29	$210.50	13.5%	17.7	
8	AK Fairbanks	with interior clear panel	10.32	1293.38	1313.85	$246.94	15.8%	15.1	
8	AK Fairbanks	with exterior low-e panel	7.12	1215.31	1231.33	$329.46	**21.1%**	**12.6**	**3.5**
8	AK Fairbanks	with interior low-e panel	9.26	1167.36	1186.23	$374.56	**24.0%**	**11.0**	**3.3**
8	AK Fairbanks	Metal frame, double pane	10.32	1759.86	1780.86	--	--	--	
8	AK Fairbanks	with exterior clear panel	10.15	1429.48	1449.42	$331.44	18.6%	11.2	
8	AK Fairbanks	with interior clear panel	9.79	1384.13	1403.71	$377.15	21.2%	9.9	
8	AK Fairbanks	with exterior low-e panel	7.83	1274.35	1291.26	$489.60	**27.5%**	**8.4**	**2.7**
8	AK Fairbanks	with interior low-e panel	8.72	1231.48	1249.64	$531.22	**29.8%**	**7.8**	**2.7**
8	AK Fairbanks	with exterior clear panel, worst case mounting	9.26	1537.46	1556.68	$224.18	12.6%	16.6	
8	AK Fairbanks	with exterior low-e panel, worst case mounting	6.94	1440.04	1456.42	$324.44	18.2%	12.8	
7	AK Anchorage	Wood frame, single pane	2.14	1380.68	1384.95	--	--	--	
7	AK Anchorage	with exterior clear panel	1.78	876.35	879.55	$505.40	36.5%	7.4	
7	AK Anchorage	with interior clear panel	1.78	850.54	854.46	$530.49	38.3%	7.0	
7	AK Anchorage	with exterior low-e panel	1.25	763.71	766.2	$618.75	**44.7%**	**6.7**	**3.7**
7	AK Anchorage	with interior low-e panel	1.6	716.5	719.88	$665.07	**48.0%**	**6.2**	**3.1**
7	AK Anchorage	Wood frame, double pane	1.96	990.34	994.61	--	--	--	
7	AK Anchorage	with exterior clear panel	1.6	843.71	846.56	$148.05	14.9%	25.1	
7	AK Anchorage	with interior clear panel	1.6	817.57	820.95	$173.66	17.5%	21.4	
7	AK Anchorage	with exterior low-e panel	1.25	750.58	753.07	$241.54	**24.3%**	**17.1**	**4.5**
7	AK Anchorage	with interior low-e panel	1.6	716.24	719.09	$275.52	**27.7%**	**15.0**	**4.1**
7	AK Anchorage	Metal frame, double pane	1.6	1169.81	1172.84	--	--	--	
7	AK Anchorage	with exterior clear panel	1.6	918.81	921.84	$251.00	21.4%	14.8	
7	AK Anchorage	with interior clear panel	1.6	885.41	888.26	$284.58	24.3%	13.1	
7	AK Anchorage	with exterior low-e panel	1.25	795.1	797.59	$375.25	**32.0%**	**11.0**	**3.4**
7	AK Anchorage	with interior low-e panel	1.42	763.37	766.04	$406.80	**34.7%**	**10.2**	**3.4**
7	AK Anchorage	with exterior clear panel, worst case mounting	1.6	1005.06	1007.91	$164.93	14.1%	22.5	
7	AK Anchorage	with exterior low-e panel, worst case mounting	1.07	925.74	927.88	$244.96	20.9%	16.9	

Climate Zone	Location	Window	HVAC	Whole House Cooling		Whole House Heating		Source Energy		% source energy savings
7	MN Duluth	Wood frame, single pane	Furnace / AC	337	kWh	175.2	MBtu	195.2	MBtu	--
7	MN Duluth	with exterior clear panel	Furnace / AC	319	kWh	106.6	MBtu	120.1	MBtu	38.5%
7	MN Duluth	with interior clear panel	Furnace / AC	322	kWh	103	MBtu	116.2	MBtu	40.5%
7	MN Duluth	with exterior low-e panel	Furnace / AC	289	kWh	93.2	MBtu	105.1	MBtu	**46.2%**
7	MN Duluth	with interior low-e panel	Furnace / AC	331	kWh	86.1	MBtu	97.8	MBtu	**49.9%**
7	MN Duluth	Wood frame, double pane	Furnace / AC	331	kWh	121.6	MBtu	136.6	MBtu	--
7	MN Duluth	with exterior clear panel	Furnace / AC	301	kWh	102.6	MBtu	115.5	MBtu	15.4%
7	MN Duluth	with interior clear panel	Furnace / AC	319	kWh	98.7	MBtu	111.4	MBtu	18.4%
7	MN Duluth	with exterior low-e panel	Furnace / AC	280	kWh	91.9	MBtu	103.6	MBtu	**24.2%**
7	MN Duluth	with interior low-e panel	Furnace / AC	318	kWh	86.4	MBtu	98.0	MBtu	**28.3%**
7	MN Duluth	Metal frame, double pane	Furnace / AC	296	kWh	145.2	MBtu	162.0	MBtu	--
7	MN Duluth	with exterior clear panel	Furnace / AC	307	kWh	112	MBtu	125.8	MBtu	22.3%
7	MN Duluth	with interior clear panel	Furnace / AC	297	kWh	107.6	MBtu	120.9	MBtu	25.3%
7	MN Duluth	with exterior low-e panel	Furnace / AC	286	kWh	97.4	MBtu	109.6	MBtu	**32.3%**
7	MN Duluth	with interior low-e panel	Furnace / AC	307	kWh	92.7	MBtu	104.8	MBtu	**35.3%**
7	MN Duluth	with exterior clear panel, worst case mounting	Furnace / AC	284	kWh	123.4	MBtu	138.0	MBtu	14.8%
7	MN Duluth	with exterior low-e panel, worst case mounting	Furnace / AC	258	kWh	114.4	MBtu	127.9	MBtu	21.0%
6	MN Minneapolis	Wood frame, single pane	Furnace / AC	1161	kWh	137.4	MBtu	163.4	MBtu	--
6	MN Minneapolis	with exterior clear panel	Furnace / AC	1064	kWh	84	MBtu	103.9	MBtu	36.4%
6	MN Minneapolis	with interior clear panel	Furnace / AC	1067	kWh	81.2	MBtu	100.9	MBtu	38.2%
6	MN Minneapolis	with exterior low-e panel	Furnace / AC	987	kWh	73.6	MBtu	91.7	MBtu	**43.9%**
6	MN Minneapolis	with interior low-e panel	Furnace / AC	1064	kWh	68.1	MBtu	86.6	MBtu	**47.0%**
6	MN Minneapolis	Wood frame, double pane	Furnace / AC	1116	kWh	95.7	MBtu	117.3	MBtu	--
6	MN Minneapolis	with exterior clear panel	Furnace / AC	1025	kWh	81	MBtu	100.2	MBtu	14.6%
6	MN Minneapolis	with interior clear panel	Furnace / AC	1056	kWh	77.9	MBtu	97.2	MBtu	17.2%
6	MN Minneapolis	with exterior low-e panel	Furnace / AC	948	kWh	72.7	MBtu	90.3	MBtu	**23.1%**
6	MN Minneapolis	with interior low-e panel	Furnace / AC	1030	kWh	68.3	MBtu	86.4	MBtu	**26.3%**
6	MN Minneapolis	Metal frame, double pane	Furnace / AC	1040	kWh	114.2	MBtu	136.6	MBtu	--
6	MN Minneapolis	with exterior clear panel	Furnace / AC	1043	kWh	88.3	MBtu	108.4	MBtu	20.7%
6	MN Minneapolis	with interior clear panel	Furnace / AC	1031	kWh	84.9	MBtu	104.5	MBtu	23.5%
6	MN Minneapolis	with exterior low-e panel	Furnace / AC	971	kWh	77	MBtu	95.2	MBtu	**30.3%**
6	MN Minneapolis	with interior low-e panel	Furnace / AC	1005	kWh	73.2	MBtu	91.5	MBtu	**33.1%**
6	MN Minneapolis	with exterior clear panel, worst case mounting	Furnace / AC	994	kWh	97.2	MBtu	117.6	MBtu	14.0%
6	MN Minneapolis	with exterior low-e panel, worst case mounting	Furnace / AC	914	kWh	90.2	MBtu	109.0	MBtu	20.2%

Climate Zone	Location	Window	Cooling Cost ($)	Heating Cost ($)	Total Cost ($)	Energy cost savings	% energy cost savings	Simple payback	Payback for low-e
7	MN Duluth	Wood frame, single pane	22.06	1365.1	1403.42	--	--	--	
7	MN Duluth	with exterior clear panel	18.31	830.25	866.52	$536.90	38.3%	6.9	
7	MN Duluth	with interior clear panel	19.04	802.48	839.19	$564.23	40.2%	6.6	
7	MN Duluth	with exterior low-e panel	15.62	725.84	758.79	$644.63	**45.9%**	**6.4**	**3.9**
7	MN Duluth	with interior low-e panel	18.13	670.7	708.43	$694.99	**49.5%**	**6.0**	**3.2**
7	MN Duluth	Wood frame, double pane	20.63	947.44	985.17	--	--	--	
7	MN Duluth	with exterior clear panel	16.76	799.19	833.5	$151.67	15.4%	24.5	
7	MN Duluth	with interior clear panel	17.9	768.65	805.02	$180.15	18.3%	20.6	
7	MN Duluth	with exterior low-e panel	14.59	716.17	748.09	$237.08	**24.1%**	**17.4**	**4.9**
7	MN Duluth	with interior low-e panel	16.76	672.78	709.03	$276.14	**28.0%**	**15.0**	**4.4**
7	MN Duluth	Metal frame, double pane	18.13	1131.08	1164.82	--	--	--	
7	MN Duluth	with exterior clear panel	17.56	872.81	907.81	$257.01	22.1%	14.5	
7	MN Duluth	with interior clear panel	17.1	838.43	872.29	$292.53	25.1%	12.7	
7	MN Duluth	with exterior low-e panel	15.73	758.98	791.58	$373.24	**32.0%**	**11.1**	**3.6**
7	MN Duluth	with interior low-e panel	16.3	721.78	756.78	$408.04	**35.0%**	**10.1**	**3.6**
7	MN Duluth	with exterior clear panel, worst case mounting	16.76	961.08	993.46	$171.36	14.7%	21.7	
7	MN Duluth	with exterior low-e panel, worst case mounting	14.14	891.18	920.59	$244.23	21.0%	16.9	
6	MN Minneapolis	Wood frame, single pane	90.96	1070.4	1202.41	--	--	--	
6	MN Minneapolis	with exterior clear panel	78.57	654.27	775.25	$427.16	35.5%	8.7	
6	MN Minneapolis	with interior clear panel	78.66	632.17	753.81	$448.60	37.3%	8.3	
6	MN Minneapolis	with exterior low-e panel	70.57	573.53	686.05	$516.36	**42.9%**	**8.0**	**4.7**
6	MN Minneapolis	with interior low-e panel	76.49	530.44	651.74	$550.67	**45.8%**	**7.5**	**4.1**
6	MN Minneapolis	Wood frame, double pane	84.25	745.6	872.82	--	--	--	
6	MN Minneapolis	with exterior clear panel	75.01	630.73	747.58	$125.24	14.3%	29.7	
6	MN Minneapolis	with interior clear panel	77.41	607	727.38	$145.44	16.7%	25.6	
6	MN Minneapolis	with exterior low-e panel	67.26	566.4	674.47	$198.35	**22.7%**	**20.9**	**5.7**
6	MN Minneapolis	with interior low-e panel	73.87	532.22	649.64	$223.18	**25.6%**	**18.5**	**5.4**
6	MN Minneapolis	Metal frame, double pane	79.8	889.39	1007.95	--	--	--	
6	MN Minneapolis	with exterior clear panel	77.75	688.02	806.92	$201.03	19.9%	18.5	
6	MN Minneapolis	with interior clear panel	76.27	661	778.53	$229.42	22.8%	16.2	
6	MN Minneapolis	with exterior low-e panel	69.54	599.47	710.16	$297.79	**29.5%**	**13.9**	**4.3**
6	MN Minneapolis	with interior low-e panel	72.39	570.05	684.62	$323.33	**32.1%**	**12.8**	**4.5**
6	MN Minneapolis	with exterior clear panel, worst case mounting	74.78	757.01	870.33	$137.62	13.7%	27.0	
6	MN Minneapolis	with exterior low-e panel, worst case mounting	66.46	702.95	807.15	$200.80	19.9%	20.6	

Climate Zone	Location	Window	HVAC	Whole House Cooling		Whole House Heating		Source Energy		% source energy savings
6	VT Burlington	Wood frame, single pane	Furnace / AC	714	kWh	128.1	MBtu	148.1	MBtu	--
6	VT Burlington	with exterior clear panel	Furnace / AC	675	kWh	78.7	MBtu	93.7	MBtu	36.7%
6	VT Burlington	with interior clear panel	Furnace / AC	679	kWh	76.1	MBtu	90.9	MBtu	38.6%
6	VT Burlington	with exterior low-e panel	Furnace / AC	628	kWh	68.7	MBtu	82.2	MBtu	**44.5%**
6	VT Burlington	with interior low-e panel	Furnace / AC	681	kWh	63.5	MBtu	77.2	MBtu	**47.9%**
6	VT Burlington	Wood frame, double pane	Furnace / AC	703	kWh	89.5	MBtu	105.8	MBtu	--
6	VT Burlington	with exterior clear panel	Furnace / AC	648	kWh	75.9	MBtu	90.3	MBtu	14.6%
6	VT Burlington	with interior clear panel	Furnace / AC	672	kWh	73.1	MBtu	87.5	MBtu	17.3%
6	VT Burlington	with exterior low-e panel	Furnace / AC	605	kWh	67.8	MBtu	81.0	MBtu	**23.5%**
6	VT Burlington	with interior low-e panel	Furnace / AC	659	kWh	63.7	MBtu	77.1	MBtu	**27.1%**
6	VT Burlington	Metal frame, double pane	Furnace / AC	637	kWh	106.8	MBtu	123.9	MBtu	--
6	VT Burlington	with exterior clear panel	Furnace / AC	660	kWh	82.9	MBtu	98.1	MBtu	20.8%
6	VT Burlington	with interior clear panel	Furnace / AC	655	kWh	79.7	MBtu	94.6	MBtu	23.7%
6	VT Burlington	with exterior low-e panel	Furnace / AC	616	kWh	71.8	MBtu	85.5	MBtu	**31.0%**
6	VT Burlington	with interior low-e panel	Furnace / AC	639	kWh	68.4	MBtu	82.0	MBtu	**33.8%**
6	VT Burlington	with exterior clear panel, worst case mounting	Furnace / AC	622	kWh	91.1	MBtu	106.6	MBtu	14.0%
6	VT Burlington	with exterior low-e panel, worst case mounting	Furnace / AC	568	kWh	84.3	MBtu	98.6	MBtu	20.5%
5	CO Denver	Wood frame, single pane	Furnace / AC	1078	kWh	77.8	MBtu	97.3	MBtu	--
5	CO Denver	with exterior clear panel	Furnace / AC	983	kWh	45.4	MBtu	60.9	MBtu	37.5%
5	CO Denver	with interior clear panel	Furnace / AC	989	kWh	43.7	MBtu	59.1	MBtu	39.3%
5	CO Denver	with exterior low-e panel	Furnace / AC	886	kWh	38.3	MBtu	52.0	MBtu	**46.6%**
5	CO Denver	with interior low-e panel	Furnace / AC	966	kWh	34.2	MBtu	48.4	MBtu	**50.2%**
5	CO Denver	Wood frame, double pane	Furnace / AC	1040	kWh	52.2	MBtu	68.9	MBtu	--
5	CO Denver	with exterior clear panel	Furnace / AC	942	kWh	43.6	MBtu	58.4	MBtu	15.3%
5	CO Denver	with interior clear panel	Furnace / AC	973	kWh	41.5	MBtu	56.5	MBtu	18.1%
5	CO Denver	with exterior low-e panel	Furnace / AC	847	kWh	37.9	MBtu	51.1	MBtu	**25.9%**
5	CO Denver	with interior low-e panel	Furnace / AC	929	kWh	34.6	MBtu	48.4	MBtu	**29.7%**
5	CO Denver	Metal frame, double pane	Furnace / AC	972	kWh	65.9	MBtu	83.1	MBtu	--
5	CO Denver	with exterior clear panel	Furnace / AC	968	kWh	48.8	MBtu	64.4	MBtu	22.5%
5	CO Denver	with interior clear panel	Furnace / AC	954	kWh	46.7	MBtu	62.0	MBtu	25.5%
5	CO Denver	with exterior low-e panel	Furnace / AC	879	kWh	40.8	MBtu	54.6	MBtu	**34.3%**
5	CO Denver	with interior low-e panel	Furnace / AC	917	kWh	38.2	MBtu	52.2	MBtu	**37.1%**
5	CO Denver	with exterior clear panel, worst case mounting	Furnace / AC	925	kWh	55.4	MBtu	71.1	MBtu	14.4%
5	CO Denver	with exterior low-e panel, worst case mounting	Furnace / AC	827	kWh	50.6	MBtu	64.8	MBtu	22.1%

Climate Zone	Location	Window	Cooling Cost ($)	Heating Cost ($)	Total Cost ($)	Energy cost savings	% energy cost savings	Simple payback	Payback for low-e
6	VT Burlington	Wood frame, single pane	78.59	2093.85	2217.44	--	--	--	
6	VT Burlington	with exterior clear panel	67.12	1286.71	1403.48	$813.96	36.7%	4.6	
6	VT Burlington	with interior clear panel	67.3	1244.69	1362.16	$855.28	38.6%	4.3	
6	VT Burlington	with exterior low-e panel	58.82	1122.74	1231.38	$986.06	**44.5%**	**4.2**	**2.4**
6	VT Burlington	with interior low-e panel	65.22	1038.39	1156.2	$1,061.24	**47.9%**	**3.9**	**2.0**
6	VT Burlington	Wood frame, double pane	72.31	1462.98	1584.6	--	--	--	
6	VT Burlington	with exterior clear panel	63.49	1241.62	1353.72	$230.88	14.6%	16.1	
6	VT Burlington	with interior clear panel	65.74	1195.59	1311.85	$272.75	17.2%	13.6	
6	VT Burlington	with exterior low-e panel	55.36	1108.04	1212.7	$371.90	**23.5%**	**11.1**	**3.0**
6	VT Burlington	with interior low-e panel	62.63	1042.2	1156.21	$428.39	**27.0%**	**9.7**	**2.7**
6	VT Burlington	Metal frame, double pane	67.64	1747	1857.2	--	--	--	
6	VT Burlington	with exterior clear panel	65.91	1355.06	1469.24	$387.96	20.9%	9.6	
6	VT Burlington	with interior clear panel	64.36	1302.72	1416.03	$441.17	23.8%	8.4	
6	VT Burlington	with exterior low-e panel	57.78	1174.34	1280.91	$576.29	**31.0%**	**7.2**	**2.2**
6	VT Burlington	with interior low-e panel	60.9	1117.91	1228.46	$628.74	**33.9%**	**6.6**	**2.2**
6	VT Burlington	with exterior clear panel, worst case mounting	62.8	1490.11	1597.72	$259.48	14.0%	14.3	
6	VT Burlington	with exterior low-e panel, worst case mounting	54.84	1377.5	1475.76	$381.44	20.5%	10.8	
5	CO Denver	Wood frame, single pane	110.63	627.47	750.04	--	--	--	
5	CO Denver	with exterior clear panel	98.61	366.1	478.16	$271.88	36.2%	13.7	
5	CO Denver	with interior clear panel	98.84	352.27	465.02	$285.02	38.0%	13.0	
5	CO Denver	with exterior low-e panel	88.81	309.19	410.19	$339.85	**45.3%**	**12.2**	**6.2**
5	CO Denver	with interior low-e panel	95.99	276.02	386.14	$363.90	**48.5%**	**11.4**	**5.3**
5	CO Denver	Wood frame, double pane	104.54	421.57	540.13	--	--	--	
5	CO Denver	with exterior clear panel	94.28	352.01	459.4	$80.73	14.9%	46.0	
5	CO Denver	with interior clear panel	97.24	335.24	446.16	$93.97	17.4%	39.6	
5	CO Denver	with exterior low-e panel	84.93	305.96	402.52	$137.61	**25.5%**	**30.1**	**7.4**
5	CO Denver	with interior low-e panel	92.68	278.94	384.85	$155.28	**28.7%**	**26.6**	**6.9**
5	CO Denver	Metal frame, double pane	100.21	531.8	642.61	--	--	--	
5	CO Denver	with exterior clear panel	97.58	393.64	503.99	$138.62	21.6%	26.8	
5	CO Denver	with interior clear panel	95.87	376.75	485.51	$157.10	24.4%	23.7	
5	CO Denver	with exterior low-e panel	87.89	329.24	429.45	$213.16	**33.2%**	**19.4**	**5.6**
5	CO Denver	with interior low-e panel	91.2	308.1	412.64	$229.97	**35.8%**	**18.0**	**5.8**
5	CO Denver	with exterior clear panel, worst case mounting	94.62	446.82	552.27	$90.34	14.1%	41.1	
5	CO Denver	with exterior low-e panel, worst case mounting	85.04	408.47	502.75	$139.86	21.8%	29.6	

Climate Zone	Location	Window	HVAC	Whole House Cooling		Whole House Heating		Source Energy		% source energy savings
5	ID Boise	Wood frame, single pane	Furnace / AC	1348	kWh	84.3	MBtu	107.5	MBtu	--
5	ID Boise	with exterior clear panel	Furnace / AC	1180	kWh	50.2	MBtu	68.4	MBtu	36.4%
5	ID Boise	with interior clear panel	Furnace / AC	1183	kWh	48.5	MBtu	66.5	MBtu	38.1%
5	ID Boise	with exterior low-e panel	Furnace / AC	1067	kWh	42.9	MBtu	59.1	MBtu	**45.0%**
5	ID Boise	with interior low-e panel	Furnace / AC	1139	kWh	38.9	MBtu	55.6	MBtu	**48.3%**
5	ID Boise	Wood frame, double pane	Furnace / AC	1258	kWh	57.6	MBtu	77.3	MBtu	--
5	ID Boise	with exterior clear panel	Furnace / AC	1143	kWh	48.4	MBtu	66.0	MBtu	14.7%
5	ID Boise	with interior clear panel	Furnace / AC	1165	kWh	46.4	MBtu	64.0	MBtu	17.2%
5	ID Boise	with exterior low-e panel	Furnace / AC	1023	kWh	42.4	MBtu	58.0	MBtu	**24.9%**
5	ID Boise	with interior low-e panel	Furnace / AC	1105	kWh	39.2	MBtu	55.5	MBtu	**28.3%**
5	ID Boise	Metal frame, double pane	Furnace / AC	1218	kWh	71.2	MBtu	91.7	MBtu	--
5	ID Boise	with exterior clear panel	Furnace / AC	1183	kWh	53.7	MBtu	72.2	MBtu	21.3%
5	ID Boise	with interior clear panel	Furnace / AC	1163	kWh	51.5	MBtu	69.6	MBtu	24.1%
5	ID Boise	with exterior low-e panel	Furnace / AC	1059	kWh	45.3	MBtu	61.6	MBtu	**32.8%**
5	ID Boise	with interior low-e panel	Furnace / AC	1095	kWh	42.8	MBtu	59.3	MBtu	**35.3%**
5	ID Boise	with exterior clear panel, worst case mounting	Furnace / AC	1152	kWh	60.2	MBtu	79.0	MBtu	13.9%
5	ID Boise	with exterior low-e panel, worst case mounting	Furnace / AC	1041	kWh	55.1	MBtu	72.1	MBtu	21.4%
5	IL Chicago	Wood frame, single pane	Furnace / AC	1303	kWh	110.9	MBtu	136.1	MBtu	--
5	IL Chicago	with exterior clear panel	Furnace / AC	1207	kWh	67.1	MBtu	87.1	MBtu	36.0%
5	IL Chicago	with interior clear panel	Furnace / AC	1214	kWh	64.9	MBtu	84.8	MBtu	37.7%
5	IL Chicago	with exterior low-e panel	Furnace / AC	1126	kWh	58.4	MBtu	76.7	MBtu	**43.6%**
5	IL Chicago	with interior low-e panel	Furnace / AC	1219	kWh	53.8	MBtu	72.7	MBtu	**46.5%**
5	IL Chicago	Wood frame, double pane	Furnace / AC	1261	kWh	76.6	MBtu	98.1	MBtu	--
5	IL Chicago	with exterior clear panel	Furnace / AC	1162	kWh	64.9	MBtu	84.2	MBtu	14.2%
5	IL Chicago	with interior clear panel	Furnace / AC	1200	kWh	62.3	MBtu	81.8	MBtu	16.6%
5	IL Chicago	with exterior low-e panel	Furnace / AC	1078	kWh	57.7	MBtu	75.4	MBtu	**23.2%**
5	IL Chicago	with interior low-e panel	Furnace / AC	1183	kWh	54.1	MBtu	72.7	MBtu	**26.0%**
5	IL Chicago	Metal frame, double pane	Furnace / AC	1178	kWh	92.2	MBtu	114.2	MBtu	--
5	IL Chicago	with exterior clear panel	Furnace / AC	1180	kWh	71	MBtu	91.1	MBtu	20.3%
5	IL Chicago	with interior clear panel	Furnace / AC	1166	kWh	68.1	MBtu	87.8	MBtu	23.2%
5	IL Chicago	with exterior low-e panel	Furnace / AC	1102	kWh	61.2	MBtu	79.5	MBtu	**30.4%**
5	IL Chicago	with interior low-e panel	Furnace / AC	1151	kWh	58.1	MBtu	76.7	MBtu	**32.9%**
5	IL Chicago	with exterior clear panel, worst case mounting	Furnace / AC	1131	kWh	78.3	MBtu	98.5	MBtu	13.8%
5	IL Chicago	with exterior low-e panel, worst case mounting	Furnace / AC	1042	kWh	72.3	MBtu	90.9	MBtu	20.4%

Climate Zone	Location	Window	Cooling Cost ($)	Heating Cost ($)	Total Cost ($)	Energy cost savings	% energy cost savings	Simple payback	Payback for low-e
5	ID Boise	Wood frame, single pane	100.28	689.79	803.97	--	--	--	
5	ID Boise	with exterior clear panel	88.49	410.99	511.29	$292.68	36.4%	12.7	
5	ID Boise	with interior clear panel	88.57	396.41	496.97	$307.00	38.2%	12.1	
5	ID Boise	with exterior low-e panel	80.33	350.72	441.42	$362.55	**45.1%**	**11.4**	**6.0**
5	ID Boise	with interior low-e panel	85.51	318.16	414.98	$388.99	**48.4%**	**10.6**	**5.1**
5	ID Boise	Wood frame, double pane	93.59	471.19	578.12	--	--	--	
5	ID Boise	with exterior clear panel	85.26	396.21	493.37	$84.75	14.7%	43.9	
5	ID Boise	with interior clear panel	87.21	379.4	478.43	$99.69	17.2%	37.3	
5	ID Boise	with exterior low-e panel	76.93	346.46	433.42	$144.70	**25.0%**	**28.6**	**7.0**
5	ID Boise	with interior low-e panel	83.05	320.57	414.5	$163.62	**28.3%**	**25.3**	**6.6**
5	ID Boise	Metal frame, double pane	91.38	582.74	686.27	--	--	--	
5	ID Boise	with exterior clear panel	88.32	439.24	539.8	$146.47	21.3%	25.4	
5	ID Boise	with interior clear panel	86.79	420.92	519.78	$166.49	24.3%	22.3	
5	ID Boise	with exterior low-e panel	79.65	370.84	460.86	$225.41	**32.8%**	**18.4**	**5.3**
5	ID Boise	with interior low-e panel	82.28	349.74	442.82	$243.45	**35.5%**	**17.0**	**5.5**
5	ID Boise	with exterior clear panel, worst case mounting	86.45	492.62	590.54	$95.73	13.9%	38.8	
5	ID Boise	with exterior low-e panel, worst case mounting	78.12	450.54	539.03	$147.24	21.5%	28.1	
5	IL Chicago	Wood frame, single pane	111.31	892.01	1040.16	--	--	--	
5	IL Chicago	with exterior clear panel	98.27	539.75	677.35	$362.81	34.9%	10.2	
5	IL Chicago	with interior clear panel	98.5	521.48	659.88	$380.28	36.6%	9.8	
5	IL Chicago	with exterior low-e panel	89.72	469.75	598.11	$442.05	**42.5%**	**9.4**	**5.3**
5	IL Chicago	with interior low-e panel	96.56	432.79	571.76	$468.40	**45.0%**	**8.8**	**4.8**
5	IL Chicago	Wood frame, double pane	103.97	615.87	759.62	--	--	--	
5	IL Chicago	with exterior clear panel	94.73	521.4	653.87	$105.75	13.9%	35.1	
5	IL Chicago	with interior clear panel	97.01	501.19	637.99	$121.63	16.0%	30.6	
5	IL Chicago	with exterior low-e panel	85.5	464.11	587	$172.62	**22.7%**	**24.0**	**6.3**
5	IL Chicago	with interior low-e panel	93.48	434.76	569.62	$190.00	**25.0%**	**21.8**	**6.1**
5	IL Chicago	Metal frame, double pane	99.75	741.25	875.54	--	--	--	
5	IL Chicago	with exterior clear panel	97.13	570.52	705.04	$170.50	19.5%	21.8	
5	IL Chicago	with interior clear panel	95.99	547.66	680.58	$194.96	22.3%	19.1	
5	IL Chicago	with exterior low-e panel	88.58	492.43	618.06	$257.48	**29.4%**	**16.1**	**4.8**
5	IL Chicago	with interior low-e panel	92	467.48	598.69	$276.85	**31.6%**	**14.9**	**5.1**
5	IL Chicago	with exterior clear panel, worst case mounting	94.28	629.46	758.39	$117.15	13.4%	31.7	
5	IL Chicago	with exterior low-e panel, worst case mounting	85.61	581.41	700.2	$175.34	20.0%	23.6	

Climate Zone	Location	Window	HVAC	Whole House Cooling		Whole House Heating		Source Energy		% source energy savings
5	MA Boston	Wood frame, single pane	Furnace / AC	888	kWh	102.6	MBtu	122.2	MBtu	--
5	MA Boston	with exterior clear panel	Furnace / AC	876	kWh	60.3	MBtu	75.9	MBtu	37.9%
5	MA Boston	with interior clear panel	Furnace / AC	884	kWh	58.1	MBtu	73.6	MBtu	39.8%
5	MA Boston	with exterior low-e panel	Furnace / AC	813	kWh	52.5	MBtu	66.7	MBtu	**45.5%**
5	MA Boston	with interior low-e panel	Furnace / AC	886	kWh	47.8	MBtu	62.4	MBtu	**49.0%**
5	MA Boston	Wood frame, double pane	Furnace / AC	915	kWh	69.3	MBtu	86.2	MBtu	--
5	MA Boston	with exterior clear panel	Furnace / AC	844	kWh	58.4	MBtu	73.5	MBtu	14.8%
5	MA Boston	with interior clear panel	Furnace / AC	875	kWh	55.8	MBtu	71.0	MBtu	17.6%
5	MA Boston	with exterior low-e panel	Furnace / AC	777	kWh	52	MBtu	65.7	MBtu	**23.8%**
5	MA Boston	with interior low-e panel	Furnace / AC	863	kWh	48.2	MBtu	62.5	MBtu	**27.4%**
5	MA Boston	Metal frame, double pane	Furnace / AC	815	kWh	84.3	MBtu	101.4	MBtu	--
5	MA Boston	with exterior clear panel	Furnace / AC	848	kWh	64	MBtu	79.6	MBtu	21.5%
5	MA Boston	with interior clear panel	Furnace / AC	847	kWh	61.3	MBtu	76.7	MBtu	24.4%
5	MA Boston	with exterior low-e panel	Furnace / AC	803	kWh	55.2	MBtu	69.5	MBtu	**31.5%**
5	MA Boston	with interior low-e panel	Furnace / AC	829	kWh	52	MBtu	66.3	MBtu	**34.6%**
5	MA Boston	with exterior clear panel, worst case mounting	Furnace / AC	797	kWh	71.2	MBtu	86.9	MBtu	14.3%
5	MA Boston	with exterior low-e panel, worst case mounting	Furnace / AC	734	kWh	65.8	MBtu	80.3	MBtu	20.8%
5	NY Rochester	Wood frame, single pane	Furnace / AC	1123	kWh	116.6	MBtu	140.2	MBtu	--
5	NY Rochester	with exterior clear panel	Furnace / AC	1047	kWh	71.8	MBtu	90.4	MBtu	35.5%
5	NY Rochester	with interior clear panel	Furnace / AC	1053	kWh	69.4	MBtu	87.9	MBtu	37.3%
5	NY Rochester	with exterior low-e panel	Furnace / AC	976	kWh	62.6	MBtu	79.6	MBtu	**43.3%**
5	NY Rochester	with interior low-e panel	Furnace / AC	1055	kWh	58	MBtu	75.4	MBtu	**46.2%**
5	NY Rochester	Wood frame, double pane	Furnace / AC	1093	kWh	81.7	MBtu	101.8	MBtu	--
5	NY Rochester	with exterior clear panel	Furnace / AC	1006	kWh	69.3	MBtu	87.2	MBtu	14.3%
5	NY Rochester	with interior clear panel	Furnace / AC	1040	kWh	66.8	MBtu	84.9	MBtu	16.6%
5	NY Rochester	with exterior low-e panel	Furnace / AC	938	kWh	61.8	MBtu	78.3	MBtu	**23.1%**
5	NY Rochester	with interior low-e panel	Furnace / AC	1028	kWh	58.3	MBtu	75.5	MBtu	**25.8%**
5	NY Rochester	Metal frame, double pane	Furnace / AC	1011	kWh	97.3	MBtu	117.9	MBtu	--
5	NY Rochester	with exterior clear panel	Furnace / AC	1023	kWh	75.7	MBtu	94.4	MBtu	19.9%
5	NY Rochester	with interior clear panel	Furnace / AC	1010	kWh	72.7	MBtu	91.0	MBtu	22.8%
5	NY Rochester	with exterior low-e panel	Furnace / AC	956	kWh	65.5	MBtu	82.5	MBtu	**30.0%**
5	NY Rochester	with interior low-e panel	Furnace / AC	998	kWh	62.4	MBtu	79.6	MBtu	**32.5%**
5	NY Rochester	with exterior clear panel, worst case mounting	Furnace / AC	976	kWh	83.1	MBtu	102.0	MBtu	13.5%
5	NY Rochester	with exterior low-e panel, worst case mounting	Furnace / AC	897	kWh	76.7	MBtu	94.1	MBtu	20.2%

Climate Zone	Location	Window	Cooling Cost ($)	Heating Cost ($)	Total Cost ($)	Energy cost savings	% energy cost savings	Simple payback	Payback for low-e
5	MA Boston	Wood frame, single pane	91.34	1384.96	1517.27	--	--	--	
5	MA Boston	with exterior clear panel	81.35	813.82	944.34	$572.93	37.8%	6.5	
5	MA Boston	with interior clear panel	81.5	784.04	915.76	$601.51	39.6%	6.2	
5	MA Boston	with exterior low-e panel	73.46	708.1	829.24	$688.03	**45.3%**	**6.0**	**3.6**
5	MA Boston	with interior low-e panel	80.31	645.87	777.88	$739.39	**48.7%**	**5.6**	**3.0**
5	MA Boston	Wood frame, double pane	86.42	935.63	1071.97	--	--	--	
5	MA Boston	with exterior clear panel	77.78	787.89	913.65	$158.32	14.8%	23.5	
5	MA Boston	with interior clear panel	80.31	753.77	884.15	$187.82	17.5%	19.8	
5	MA Boston	with exterior low-e panel	69.58	701.37	817.14	$254.83	**23.8%**	**16.2**	**4.4**
5	MA Boston	with interior low-e panel	77.63	650.31	778.9	$293.07	**27.3%**	**14.1**	**4.0**
5	MA Boston	Metal frame, double pane	81.95	1138.37	1259.81	--	--	--	
5	MA Boston	with exterior clear panel	80.01	864.57	990.92	$268.89	21.3%	13.8	
5	MA Boston	with interior clear panel	78.52	827.46	953.66	$306.15	24.3%	12.1	
5	MA Boston	with exterior low-e panel	71.97	744.9	864.55	$395.26	**31.4%**	**10.5**	**3.3**
5	MA Boston	with interior low-e panel	75.39	702.58	826.1	$433.71	**34.4%**	**9.5**	**3.3**
5	MA Boston	with exterior clear panel, worst case mounting	77.48	961.35	1080.1	$179.71	14.3%	20.7	
5	MA Boston	with exterior low-e panel, worst case mounting	69.73	888.49	997.86	$261.95	20.8%	15.8	
5	NY Rochester	Wood frame, single pane	150.8	1561.78	1760.55	--	--	--	
5	NY Rochester	with exterior clear panel	133.28	961.83	1147.15	$613.40	34.8%	6.1	
5	NY Rochester	with interior clear panel	133.46	930.63	1117.01	$643.54	36.6%	5.8	
5	NY Rochester	with exterior low-e panel	120.89	839.13	1011.88	$748.67	**42.5%**	**5.5**	**3.1**
5	NY Rochester	with interior low-e panel	130.45	777.7	964.44	$796.11	**45.2%**	**5.2**	**2.8**
5	NY Rochester	Wood frame, double pane	141.6	1095.16	1288.62	--	--	--	
5	NY Rochester	with exterior clear panel	127.62	929.17	1107.23	$181.39	14.1%	20.5	
5	NY Rochester	with interior clear panel	131.33	895.63	1079.71	$208.91	16.2%	17.8	
5	NY Rochester	with exterior low-e panel	115.94	827.96	993.99	$294.63	**22.9%**	**14.0**	**3.7**
5	NY Rochester	with interior low-e panel	126.56	780.56	962.52	$326.10	**25.3%**	**12.7**	**3.6**
5	NY Rochester	Metal frame, double pane	134.87	1304.32	1483.27	--	--	--	
5	NY Rochester	with exterior clear panel	131.69	1013.88	1194.95	$288.32	19.4%	12.9	
5	NY Rochester	with interior clear panel	129.39	974.01	1152.78	$330.49	22.3%	11.2	
5	NY Rochester	with exterior low-e panel	119.48	877.51	1046.72	$436.55	**29.4%**	**9.5**	**2.8**
5	NY Rochester	with interior low-e panel	124.08	835.96	1012.61	$470.66	**31.7%**	**8.8**	**3.0**
5	NY Rochester	with exterior clear panel, worst case mounting	127.44	1113.69	1286.44	$196.83	13.3%	18.9	
5	NY Rochester	with exterior low-e panel, worst case mounting	115.05	1027.38	1186.15	$297.12	20.0%	13.9	

Climate Zone	Location	Window	HVAC	Whole House Cooling		Whole House Heating		Source Energy		% source energy savings
5	PA Pittsburgh	Wood frame, single pane	Furnace / AC	1172	kWh	95.6	MBtu	117.9	MBtu	--
5	PA Pittsburgh	with exterior clear panel	Furnace / AC	1092	kWh	58.4	MBtu	76.3	MBtu	35.2%
5	PA Pittsburgh	with interior clear panel	Furnace / AC	1094	kWh	56.4	MBtu	74.1	MBtu	37.1%
5	PA Pittsburgh	with exterior low-e panel	Furnace / AC	1020	kWh	50.5	MBtu	66.9	MBtu	**43.3%**
5	PA Pittsburgh	with interior low-e panel	Furnace / AC	1104	kWh	46.6	MBtu	63.6	MBtu	**46.1%**
5	PA Pittsburgh	Wood frame, double pane	Furnace / AC	1143	kWh	66.5	MBtu	85.7	MBtu	--
5	PA Pittsburgh	with exterior clear panel	Furnace / AC	1052	kWh	56.3	MBtu	73.6	MBtu	14.2%
5	PA Pittsburgh	with interior clear panel	Furnace / AC	1084	kWh	54.2	MBtu	71.6	MBtu	16.5%
5	PA Pittsburgh	with exterior low-e panel	Furnace / AC	985	kWh	49.8	MBtu	65.7	MBtu	**23.4%**
5	PA Pittsburgh	with interior low-e panel	Furnace / AC	1072	kWh	46.8	MBtu	63.4	MBtu	**26.0%**
5	PA Pittsburgh	Metal frame, double pane	Furnace / AC	1055	kWh	80.2	MBtu	99.7	MBtu	--
5	PA Pittsburgh	with exterior clear panel	Furnace / AC	1075	kWh	61.8	MBtu	79.8	MBtu	19.9%
5	PA Pittsburgh	with interior clear panel	Furnace / AC	1062	kWh	59.3	MBtu	76.9	MBtu	22.8%
5	PA Pittsburgh	with exterior low-e panel	Furnace / AC	1005	kWh	53	MBtu	69.4	MBtu	**30.4%**
5	PA Pittsburgh	with interior low-e panel	Furnace / AC	1043	kWh	50.4	MBtu	67.0	MBtu	**32.8%**
5	PA Pittsburgh	with exterior clear panel, worst case mounting	Furnace / AC	1021	kWh	68.3	MBtu	86.3	MBtu	13.4%
5	PA Pittsburgh	with exterior low-e panel, worst case mounting	Furnace / AC	948	kWh	62.8	MBtu	79.5	MBtu	20.3%
4	NY New York City	Wood frame, single pane	Furnace / AC	1453	kWh	91.5	MBtu	116.6	MBtu	--
4	NY New York City	with exterior clear panel	Furnace / AC	1330	kWh	55.2	MBtu	75.5	MBtu	35.2%
4	NY New York City	with interior clear panel	Furnace / AC	1329	kWh	53.3	MBtu	73.5	MBtu	37.0%
4	NY New York City	with exterior low-e panel	Furnace / AC	1242	kWh	48.3	MBtu	67.0	MBtu	**42.5%**
4	NY New York City	with interior low-e panel	Furnace / AC	1318	kWh	44.3	MBtu	63.5	MBtu	**45.5%**
4	NY New York City	Wood frame, double pane	Furnace / AC	1393	kWh	63	MBtu	84.8	MBtu	--
4	NY New York City	with exterior clear panel	Furnace / AC	1290	kWh	53.6	MBtu	73.3	MBtu	13.5%
4	NY New York City	with interior clear panel	Furnace / AC	1317	kWh	51.4	MBtu	71.3	MBtu	16.0%
4	NY New York City	with exterior low-e panel	Furnace / AC	1201	kWh	47.9	MBtu	66.1	MBtu	**22.0%**
4	NY New York City	with interior low-e panel	Furnace / AC	1284	kWh	44.6	MBtu	63.4	MBtu	**25.2%**
4	NY New York City	Metal frame, double pane	Furnace / AC	1331	kWh	76.1	MBtu	98.4	MBtu	--
4	NY New York City	with exterior clear panel	Furnace / AC	1316	kWh	58.6	MBtu	79.1	MBtu	19.6%
4	NY New York City	with interior clear panel	Furnace / AC	1300	kWh	56.2	MBtu	76.3	MBtu	22.4%
4	NY New York City	with exterior low-e panel	Furnace / AC	1230	kWh	50.7	MBtu	69.5	MBtu	**29.4%**
4	NY New York City	with interior low-e panel	Furnace / AC	1266	kWh	48	MBtu	67.0	MBtu	**31.9%**
4	NY New York City	with exterior clear panel, worst case mounting	Furnace / AC	1278	kWh	64.8	MBtu	85.4	MBtu	13.2%
4	NY New York City	with exterior low-e panel, worst case mounting	Furnace / AC	1187	kWh	60.1	MBtu	79.3	MBtu	19.4%

Climate Zone	Location	Window	Cooling Cost ($)	Heating Cost ($)	Total Cost ($)	Energy cost savings	% energy cost savings	Simple payback	Payback for low-e
5	PA Pittsburgh	Wood frame, single pane	117.25	1118.64	1268.66	--	--	--	
5	PA Pittsburgh	with exterior clear panel	104.7	682.92	822.7	$445.96	35.2%	8.3	
5	PA Pittsburgh	with interior clear panel	104.7	660.38	800.41	$468.25	36.9%	7.9	
5	PA Pittsburgh	with exterior low-e panel	95.36	590.67	721.23	$547.43	**43.2%**	**7.6**	**4.1**
5	PA Pittsburgh	with interior low-e panel	102.53	544.76	686.07	$582.59	**45.9%**	**7.1**	**3.7**
5	PA Pittsburgh	Wood frame, double pane	110.46	778.31	924.61	--	--	--	
5	PA Pittsburgh	with exterior clear panel	100.35	658.71	793.37	$131.24	14.2%	28.3	
5	PA Pittsburgh	with interior clear panel	103.17	634.2	772.95	$151.66	16.4%	24.5	
5	PA Pittsburgh	with exterior low-e panel	91.52	582.67	708.75	$215.86	**23.3%**	**19.2**	**5.0**
5	PA Pittsburgh	with interior low-e panel	99.2	547.02	684.24	$240.37	**26.0%**	**17.2**	**4.7**
5	PA Pittsburgh	Metal frame, double pane	105.6	938.09	1073.13	--	--	--	
5	PA Pittsburgh	with exterior clear panel	103.55	723.13	860.73	$212.40	19.8%	17.5	
5	PA Pittsburgh	with interior clear panel	101.63	694.32	830.26	$242.87	22.6%	15.3	
5	PA Pittsburgh	with exterior low-e panel	94.21	619.97	748.61	$324.52	**30.2%**	**12.7**	**3.7**
5	PA Pittsburgh	with interior low-e panel	97.66	589.33	722.83	$350.30	**32.6%**	**11.8**	**3.9**
5	PA Pittsburgh	with exterior clear panel, worst case mounting	99.71	799.54	930.23	$142.90	13.3%	26.0	
5	PA Pittsburgh	with exterior low-e panel, worst case mounting	90.88	734.67	856.01	$217.12	20.2%	19.1	
4	NY New York City	Wood frame, single pane	209.75	1226.03	1483.21	--	--	--	
4	NY New York City	with exterior clear panel	189.92	740.1	975.51	$507.70	34.2%	7.3	
4	NY New York City	with interior clear panel	189.92	714.29	949.52	$533.69	36.0%	7.0	
4	NY New York City	with exterior low-e panel	176.29	647.74	867.57	$615.64	**41.5%**	**6.7**	**3.9**
4	NY New York City	with interior low-e panel	186.2	593.97	827.26	$655.95	**44.2%**	**6.3**	**3.4**
4	NY New York City	Wood frame, double pane	199.66	844.05	1090.61	--	--	--	
4	NY New York City	with exterior clear panel	184.26	718.27	946.6	$144.01	13.2%	25.8	
4	NY New York City	with interior clear panel	188.33	688.83	921.94	$168.67	15.5%	22.0	
4	NY New York City	with exterior low-e panel	170.63	642.29	854.87	$235.74	**21.6%**	**17.5**	**4.6**
4	NY New York City	with interior low-e panel	181.96	598.1	825.37	$265.24	**24.3%**	**15.6**	**4.3**
4	NY New York City	Metal frame, double pane	192.75	1019.53	1255.12	--	--	--	
4	NY New York City	with exterior clear panel	188.51	784.72	1017.65	$237.47	18.9%	15.7	
4	NY New York City	with interior clear panel	185.85	752.89	982.99	$272.13	21.7%	13.7	
4	NY New York City	with exterior low-e panel	175.05	680.01	897.72	$357.40	**28.5%**	**11.6**	**3.5**
4	NY New York City	with interior low-e panel	179.83	643.35	867.43	$387.69	**30.9%**	**10.7**	**3.6**
4	NY New York City	with exterior clear panel, worst case mounting	183.9	868.95	1095.16	$159.96	12.7%	23.2	
4	NY New York City	with exterior low-e panel, worst case mounting	170.63	804.98	1015.08	$240.04	19.1%	17.2	

Climate Zone	Location	Window	HVAC	Whole House Cooling		Whole House Heating		Source Energy		% source energy savings
4	WA Seattle	Wood frame, single pane	Furnace / AC	257	kWh	72.1	MBtu	81.7	MBtu	--
4	WA Seattle	with exterior clear panel	Furnace / AC	239	kWh	42.5	MBtu	49.2	MBtu	39.8%
4	WA Seattle	with interior clear panel	Furnace / AC	239	kWh	40.9	MBtu	47.4	MBtu	42.0%
4	WA Seattle	with exterior low-e panel	Furnace / AC	213	kWh	35.8	MBtu	41.5	MBtu	**49.1%**
4	WA Seattle	with interior low-e panel	Furnace / AC	230	kWh	32.7	MBtu	38.3	MBtu	**53.1%**
4	WA Seattle	Wood frame, double pane	Furnace / AC	251	kWh	49	MBtu	56.4	MBtu	--
4	WA Seattle	with exterior clear panel	Furnace / AC	225	kWh	40.9	MBtu	47.2	MBtu	16.2%
4	WA Seattle	with interior clear panel	Furnace / AC	235	kWh	39.3	MBtu	45.6	MBtu	19.1%
4	WA Seattle	with exterior low-e panel	Furnace / AC	201	kWh	35.3	MBtu	40.9	MBtu	**27.5%**
4	WA Seattle	with interior low-e panel	Furnace / AC	217	kWh	32.9	MBtu	38.4	MBtu	**31.9%**
4	WA Seattle	Metal frame, double pane	Furnace / AC	221	kWh	60.4	MBtu	68.5	MBtu	--
4	WA Seattle	with exterior clear panel	Furnace / AC	232	kWh	45.5	MBtu	52.3	MBtu	23.6%
4	WA Seattle	with interior clear panel	Furnace / AC	228	kWh	43.5	MBtu	50.1	MBtu	26.8%
4	WA Seattle	with exterior low-e panel	Furnace / AC	208	kWh	37.9	MBtu	43.8	MBtu	**36.1%**
4	WA Seattle	with interior low-e panel	Furnace / AC	215	kWh	35.8	MBtu	41.6	MBtu	**39.3%**
4	WA Seattle	with exterior clear panel, worst case mounting	Furnace / AC	217	kWh	50.9	MBtu	58.1	MBtu	15.2%
4	WA Seattle	with exterior low-e panel, worst case mounting	Furnace / AC	189	kWh	46	MBtu	52.4	MBtu	23.5%
4	DC Washington	Wood frame, single pane	Furnace / AC	1860	kWh	79.8	MBtu	108.5	MBtu	--
4	DC Washington	with exterior clear panel	Furnace / AC	1676	kWh	49.1	MBtu	72.9	MBtu	32.8%
4	DC Washington	with interior clear panel	Furnace / AC	1676	kWh	47.4	MBtu	71.0	MBtu	34.6%
4	DC Washington	with exterior low-e panel	Furnace / AC	1574	kWh	42.8	MBtu	64.8	MBtu	**40.3%**
4	DC Washington	with interior low-e panel	Furnace / AC	1671	kWh	39.1	MBtu	61.9	MBtu	**43.0%**
4	DC Washington	with exterior solar-E panel	Furnace / AC	1313	kWh	46.8	MBtu	66.2	MBtu	**39.0%**
4	DC Washington	Wood frame, double pane	Furnace / AC	1760	kWh	55.9	MBtu	81.3	MBtu	--
4	DC Washington	with exterior clear panel	Furnace / AC	1626	kWh	47.6	MBtu	70.6	MBtu	13.0%
4	DC Washington	with interior clear panel	Furnace / AC	1664	kWh	45.6	MBtu	68.9	MBtu	15.2%
4	DC Washington	with exterior low-e panel	Furnace / AC	1526	kWh	42.4	MBtu	63.8	MBtu	**21.5%**
4	DC Washington	with interior low-e panel	Furnace / AC	1629	kWh	39.4	MBtu	61.7	MBtu	**24.0%**
4	DC Washington	with exterior solar-E panel	Furnace / AC	1281	kWh	46.2	MBtu	65.2	MBtu	**19.8%**
4	DC Washington	Metal frame, double pane	Furnace / AC	1687	kWh	67.8	MBtu	93.4	MBtu	--
4	DC Washington	with exterior clear panel	Furnace / AC	1657	kWh	52.2	MBtu	76.0	MBtu	18.6%
4	DC Washington	with interior clear panel	Furnace / AC	1635	kWh	50.2	MBtu	73.6	MBtu	21.2%
4	DC Washington	with exterior low-e panel	Furnace / AC	1558	kWh	45	MBtu	67.0	MBtu	**28.2%**
4	DC Washington	with interior low-e panel	Furnace / AC	1597	kWh	42.6	MBtu	64.9	MBtu	**30.6%**
4	DC Washington	with exterior solar-E panel	Furnace / AC	1305	kWh	49.1	MBtu	68.6	MBtu	**26.6%**
4	DC Washington	with exterior clear panel, worst case mounting	Furnace / AC	1612	kWh	58	MBtu	81.8	MBtu	12.4%
4	DC Washington	with exterior low-e panel, worst case mounting	Furnace / AC	1499	kWh	53.6	MBtu	75.7	MBtu	18.9%
4	DC Washington	with exterior solar-E panel, worst case mountin	Furnace / AC	1290	kWh	57.2	MBtu	77.3	MBtu	17.3%

Climate Zone	Location	Window	Cooling Cost ($)	Heating Cost ($)	Total Cost ($)	Energy cost savings	% energy cost savings	Simple payback	Payback for low-e
4	WA Seattle	Wood frame, single pane	15.64	837.41	859.26	--	--	--	
4	WA Seattle	with exterior clear panel	13.6	493.57	513.89	$345.37	40.2%	10.8	
4	WA Seattle	with interior clear panel	13.77	475.83	496.15	$363.11	42.3%	10.2	
4	WA Seattle	with exterior low-e panel	11.99	415.69	433.8	$425.46	**49.5%**	**9.7**	**5.2**
4	WA Seattle	with interior low-e panel	13.69	380.01	399.56	$459.70	**53.5%**	**9.0**	**4.3**
4	WA Seattle	Wood frame, double pane	14.71	569.28	590.62	--	--	--	
4	WA Seattle	with exterior clear panel	12.75	475.82	494.95	$95.67	16.2%	38.9	
4	WA Seattle	with interior clear panel	13.52	456.7	476.68	$113.94	19.3%	32.6	
4	WA Seattle	with exterior low-e panel	11.05	409.69	426.78	$163.84	**27.7%**	**25.3**	**6.2**
4	WA Seattle	with interior low-e panel	12.92	381.8	400.25	$190.37	**32.2%**	**21.7**	**5.5**
4	WA Seattle	Metal frame, double pane	13.43	702.23	721.02	--	--	--	
4	WA Seattle	with exterior clear panel	13.43	529.29	549.01	$172.01	23.9%	21.6	
4	WA Seattle	with interior clear panel	13.18	505.68	525.06	$195.96	27.2%	19.0	
4	WA Seattle	with exterior low-e panel	11.65	440.21	457.89	$263.13	**36.5%**	**15.7**	**4.6**
4	WA Seattle	with interior low-e panel	12.5	415.45	433.73	$287.29	**39.8%**	**14.4**	**4.6**
4	WA Seattle	with exterior clear panel, worst case mounting	12.58	592.02	610.47	$110.55	15.3%	33.6	
4	WA Seattle	with exterior low-e panel, worst case mounting	10.54	534.9	550.97	$170.05	23.6%	24.3	
4	DC Washington	Wood frame, single pane	195.94	1018.71	1247.49	--	--	--	
4	DC Washington	with exterior clear panel	174.66	627.56	833.71	$413.78	33.2%	9.0	
4	DC Washington	with interior clear panel	174.54	605.83	811.98	$435.51	34.9%	8.5	
4	DC Washington	with exterior low-e panel	161.87	546.29	739.89	$507.60	**40.7%**	**8.2**	**4.5**
4	DC Washington	with interior low-e panel	169.86	498.86	704.39	$543.10	**43.5%**	**7.6**	**3.9**
4	DC Washington	with exterior solar-E panel	137.64	598.1	759.6	$487.89	**39.1%**	**8.5**	**5.7**
4	DC Washington	Wood frame, double pane	183.76	713.51	929.99	--	--	--	
4	DC Washington	with exterior clear panel	169.25	608.21	808.21	$121.78	13.1%	30.5	
4	DC Washington	with interior clear panel	172.32	582.9	787.57	$142.42	15.3%	26.1	
4	DC Washington	with exterior low-e panel	157.07	541.18	728.88	$201.11	**21.6%**	**20.6**	**5.3**
4	DC Washington	with interior low-e panel	166.17	502.88	703.25	$226.74	**24.4%**	**18.2**	**5.0**
4	DC Washington	with exterior solar-E panel	134.19	590.46	748.02	$181.97	**19.6%**	**22.7**	**7.0**
4	DC Washington	Metal frame, double pane	178.6	865.36	1072.86	--	--	--	
4	DC Washington	with exterior clear panel	173.55	666.87	870.68	$202.18	18.8%	18.4	
4	DC Washington	with interior clear panel	170.97	640.68	841.79	$231.07	21.5%	16.1	
4	DC Washington	with exterior low-e panel	161.01	574.32	765.95	$306.91	**28.6%**	**13.5**	**4.0**
4	DC Washington	with interior low-e panel	164.94	543.63	740.06	$332.80	**31.0%**	**12.4**	**4.1**
4	DC Washington	with exterior solar-E panel	137.27	626.39	786.91	$285.95	**26.7%**	**14.5**	**5.0**
4	DC Washington	with exterior clear panel, worst case mounting	170.11	740.53	938.81	$134.05	12.5%	27.7	
4	DC Washington	with exterior low-e panel, worst case mounting	157.93	684.29	868.67	$204.19	19.0%	20.3	
4	DC Washington	with exterior solar-E panel, worst case mounting	137.88	730.87	889.54	$183.32	17.1%	22.6	

Climate Zone	Location	Window	HVAC	Whole House Cooling		Whole House Heating		Source Energy		% source energy savings
4	MO Kansas City	Wood frame, single pane	Furnace / AC	2692	kWh	86	MBtu	124.8	MBtu	--
4	MO Kansas City	with exterior clear panel	Furnace / AC	2357	kWh	52.8	MBtu	84.7	MBtu	32.1%
4	MO Kansas City	with interior clear panel	Furnace / AC	2356	kWh	51	MBtu	82.7	MBtu	33.7%
4	MO Kansas City	with exterior low-e panel	Furnace / AC	2200	kWh	46.1	MBtu	75.6	MBtu	**39.4%**
4	MO Kansas City	with interior low-e panel	Furnace / AC	2317	kWh	42.2	MBtu	72.7	MBtu	**41.8%**
4	MO Kansas City	with exterior solar-E panel	Furnace / AC	1890	kWh	50.1	MBtu	76.4	MBtu	**38.8%**
4	MO Kansas City	Wood frame, double pane	Furnace / AC	2510	kWh	60	MBtu	94.3	MBtu	--
4	MO Kansas City	with exterior clear panel	Furnace / AC	2291	kWh	51.1	MBtu	82.1	MBtu	13.0%
4	MO Kansas City	with interior clear panel	Furnace / AC	2335	kWh	49.1	MBtu	80.4	MBtu	14.7%
4	MO Kansas City	with exterior low-e panel	Furnace / AC	2137	kWh	45.6	MBtu	74.3	MBtu	**21.2%**
4	MO Kansas City	with interior low-e panel	Furnace / AC	2265	kWh	42.5	MBtu	72.4	MBtu	**23.2%**
4	MO Kansas City	with exterior solar-E panel	Furnace / AC	1844	kWh	49.5	MBtu	75.2	MBtu	**20.3%**
4	MO Kansas City	Metal frame, double pane	Furnace / AC	2425	kWh	72.4	MBtu	106.9	MBtu	--
4	MO Kansas City	with exterior clear panel	Furnace / AC	2342	kWh	56	MBtu	88.0	MBtu	17.6%
4	MO Kansas City	with interior clear panel	Furnace / AC	2309	kWh	53.8	MBtu	85.3	MBtu	20.2%
4	MO Kansas City	with exterior low-e panel	Furnace / AC	2185	kWh	48.4	MBtu	77.9	MBtu	**27.1%**
4	MO Kansas City	with interior low-e panel	Furnace / AC	2239	kWh	45.8	MBtu	75.7	MBtu	**29.2%**
4	MO Kansas City	with exterior solar-E panel	Furnace / AC	1883	kWh	52.4	MBtu	78.8	MBtu	**26.3%**
4	MO Kansas City	with exterior clear panel, worst case mounting	Furnace / AC	2299	kWh	62	MBtu	94.1	MBtu	12.0%
4	MO Kansas City	with exterior low-e panel, worst case mounting	Furnace / AC	2141	kWh	57.3	MBtu	87.2	MBtu	18.5%
4	MO Kansas City	with exterior solar-E panel, worst case mountin	Furnace / AC	1873	kWh	60.9	MBtu	88.0	MBtu	17.7%
4	NC Raleigh	Wood frame, single pane	Furnace / AC	2635	kWh	56.5	MBtu	92.0	MBtu	--
4	NC Raleigh	with exterior clear panel	Furnace / AC	2422	kWh	34.1	MBtu	65.0	MBtu	29.3%
4	NC Raleigh	with interior clear panel	Furnace / AC	2416	kWh	32.8	MBtu	63.6	MBtu	30.9%
4	NC Raleigh	with exterior low-e panel	Furnace / AC	2283	kWh	29.4	MBtu	58.3	MBtu	**36.6%**
4	NC Raleigh	with interior low-e panel	Furnace / AC	2393	kWh	26.6	MBtu	56.5	MBtu	**38.5%**
4	NC Raleigh	with exterior solar-E panel	Furnace / AC	1940	kWh	33.1	MBtu	58.4	MBtu	**36.5%**
4	NC Raleigh	Wood frame, double pane	Furnace / AC	2525	kWh	38.9	MBtu	71.5	MBtu	--
4	NC Raleigh	with exterior clear panel	Furnace / AC	2353	kWh	33.1	MBtu	63.2	MBtu	11.6%
4	NC Raleigh	with interior clear panel	Furnace / AC	2393	kWh	31.6	MBtu	62.0	MBtu	13.3%
4	NC Raleigh	with exterior low-e panel	Furnace / AC	2222	kWh	29.2	MBtu	57.4	MBtu	**19.7%**
4	NC Raleigh	with interior low-e panel	Furnace / AC	2342	kWh	26.8	MBtu	56.2	MBtu	**21.4%**
4	NC Raleigh	with exterior solar-E panel	Furnace / AC	1898	kWh	32.7	MBtu	57.5	MBtu	**19.5%**
4	NC Raleigh	Metal frame, double pane	Furnace / AC	2414	kWh	48.1	MBtu	80.2	MBtu	--
4	NC Raleigh	with exterior clear panel	Furnace / AC	2397	kWh	36.5	MBtu	67.4	MBtu	16.0%
4	NC Raleigh	with interior clear panel	Furnace / AC	2366	kWh	35	MBtu	65.4	MBtu	18.5%
4	NC Raleigh	with exterior low-e panel	Furnace / AC	2262	kWh	31.2	MBtu	60.0	MBtu	**25.2%**
4	NC Raleigh	with interior low-e panel	Furnace / AC	2318	kWh	29.3	MBtu	58.6	MBtu	**27.0%**
4	NC Raleigh	with exterior solar-E panel	Furnace / AC	1926	kWh	34.8	MBtu	60.1	MBtu	**25.1%**
4	NC Raleigh	with exterior clear panel, worst case mounting	Furnace / AC	2325	kWh	40.9	MBtu	71.4	MBtu	11.1%
4	NC Raleigh	with exterior low-e panel, worst case mounting	Furnace / AC	2186	kWh	37.8	MBtu	66.4	MBtu	17.3%
4	NC Raleigh	with exterior solar-E panel, worst case mountin	Furnace / AC	1903	kWh	41.2	MBtu	66.8	MBtu	16.7%

Climate Zone	Location	Window	Cooling Cost ($)	Heating Cost ($)	Total Cost ($)	Energy cost savings	% energy cost savings	Simple payback	Payback for low-e
4	MO Kansas City	Wood frame, single pane	225.74	1034.07	1305.96	--	--	--	
4	MO Kansas City	with exterior clear panel	197.46	635.35	873.41	$432.55	33.1%	8.6	
4	MO Kansas City	with interior clear panel	196.65	613.7	851.66	$454.30	34.8%	8.2	
4	MO Kansas City	with exterior low-e panel	183.32	554.29	776.49	$529.47	**40.5%**	**7.8**	**4.3**
4	MO Kansas City	with interior low-e panel	191.4	507.95	741.97	$563.99	**43.2%**	**7.3**	**3.8**
4	MO Kansas City	with exterior solar-E panel	157.66	603.14	794.03	$511.93	**39.2%**	**8.1**	**5.3**
4	MO Kansas City	Wood frame, double pane	208.16	721.68	975.19	--	--	--	
4	MO Kansas City	with exterior clear panel	191.9	615.31	846.7	$128.49	13.2%	28.9	
4	MO Kansas City	with interior clear panel	194.73	590.3	826.14	$149.05	15.3%	24.9	
4	MO Kansas City	with exterior low-e panel	178.16	548.89	764.73	$210.46	**21.6%**	**19.7**	**5.1**
4	MO Kansas City	with interior low-e panel	187.66	511.54	740.31	$234.88	**24.1%**	**17.6**	**4.9**
4	MO Kansas City	with exterior solar-E panel	154.03	595.32	781.56	$193.63	**19.9%**	**21.4**	**6.4**
4	MO Kansas City	Metal frame, double pane	204.12	871.49	1116.42	--	--	--	
4	MO Kansas City	with exterior clear panel	196.95	673.31	909.85	$206.57	18.5%	18.0	
4	MO Kansas City	with interior clear panel	193.82	646.96	880.17	$236.25	21.2%	15.7	
4	MO Kansas City	with exterior low-e panel	182.51	582.05	802.74	$313.68	**28.1%**	**13.2**	**3.9**
4	MO Kansas City	with interior low-e panel	186.14	551.32	777.46	$338.96	**30.4%**	**12.2**	**4.1**
4	MO Kansas City	with exterior solar-E panel	157.56	630.64	820.82	$295.60	**26.5%**	**14.0**	**4.7**
4	MO Kansas City	with exterior clear panel, worst case mounting	193.82	745.28	977.48	$138.94	12.4%	26.8	
4	MO Kansas City	with exterior low-e panel, worst case mounting	179.78	689.92	906.16	$210.26	18.8%	19.7	
4	MO Kansas City	with exterior solar-E panel, worst case mounting	158.97	732.48	921.65	$194.77	17.4%	21.2	
4	NC Raleigh	Wood frame, single pane	289.66	692.69	977.27	--	--	--	
4	NC Raleigh	with exterior clear panel	263.95	417.9	679.48	$297.79	30.5%	12.5	
4	NC Raleigh	with interior clear panel	263.3	402.96	663.89	$313.38	32.1%	11.9	
4	NC Raleigh	with exterior low-e panel	249.7	361.33	607.89	$369.38	**37.8%**	**11.2**	**5.9**
4	NC Raleigh	with interior low-e panel	258.88	326.04	584.48	$392.79	**40.2%**	**10.5**	**5.3**
4	NC Raleigh	with exterior solar-E panel	223.13	406.11	615.63	$361.64	**37.0%**	**11.4**	**6.6**
4	NC Raleigh	Wood frame, double pane	274.86	476.71	749.41	--	--	--	
4	NC Raleigh	with exterior clear panel	258.12	405.98	660.1	$89.31	11.9%	41.6	
4	NC Raleigh	with interior clear panel	261.36	387.43	645.87	$103.54	13.8%	35.9	
4	NC Raleigh	with exterior low-e panel	244.3	358.49	598.47	$150.94	**20.1%**	**27.4**	**6.8**
4	NC Raleigh	with interior low-e panel	254.88	329.27	582.21	$167.20	**22.3%**	**24.7**	**6.6**
4	NC Raleigh	with exterior solar-E panel	219.35	401.77	606.75	$142.66	**19.0%**	**29.0**	**7.9**
4	NC Raleigh	Metal frame, double pane	269.68	590.16	850.87	--	--	--	
4	NC Raleigh	with exterior clear panel	263.3	447.55	706.43	$144.44	17.0%	25.7	
4	NC Raleigh	with interior clear panel	260.06	429.47	685	$165.87	19.5%	22.4	
4	NC Raleigh	with exterior low-e panel	248.72	382.32	626.62	$224.25	**26.4%**	**18.4**	**5.3**
4	NC Raleigh	with interior low-e panel	253.15	359.29	609.63	$241.24	**28.4%**	**17.1**	**5.6**
4	NC Raleigh	with exterior solar-E panel	222.91	427.39	635.4	$215.47	**25.3%**	**19.2**	**5.9**
4	NC Raleigh	with exterior clear panel, worst case mounting	259.42	502.31	753.41	$97.46	11.5%	38.1	
4	NC Raleigh	with exterior low-e panel, worst case mounting	245.81	463.98	700.07	$150.80	17.7%	27.4	
4	NC Raleigh	with exterior solar-E panel, worst case mounting	223.88	505.18	710.7	$140.17	16.5%	29.5	

Climate Zone	Location	Window	HVAC	Whole House Cooling		Whole House Heating		Source Energy		% source energy savings
3	GA Atlanta	Wood frame, single pane	Furnace / AC	2670	kWh	49	MBtu	84.2	MBtu	--
3	GA Atlanta	with exterior clear panel	Furnace / AC	2417	kWh	29.2	MBtu	59.6	MBtu	29.1%
3	GA Atlanta	with interior clear panel	Furnace / AC	2416	kWh	28.1	MBtu	58.4	MBtu	30.6%
3	GA Atlanta	with exterior low-e panel	Furnace / AC	2268	kWh	25.2	MBtu	53.6	MBtu	**36.4%**
3	GA Atlanta	with interior low-e panel	Furnace / AC	2396	kWh	22.5	MBtu	52.1	MBtu	**38.1%**
3	GA Atlanta	with exterior solar-E panel	Furnace / AC	1897	kWh	28.8	MBtu	53.2	MBtu	**36.8%**
3	GA Atlanta	Wood frame, double pane	Furnace / AC	2534	kWh	33.3	MBtu	65.5	MBtu	--
3	GA Atlanta	with exterior clear panel	Furnace / AC	2344	kWh	28.4	MBtu	57.9	MBtu	11.5%
3	GA Atlanta	with interior clear panel	Furnace / AC	2394	kWh	27	MBtu	57.0	MBtu	13.0%
3	GA Atlanta	with exterior low-e panel	Furnace / AC	2196	kWh	25.1	MBtu	52.6	MBtu	**19.6%**
3	GA Atlanta	with interior low-e panel	Furnace / AC	2339	kWh	22.8	MBtu	51.8	MBtu	**20.9%**
3	GA Atlanta	with exterior solar-E panel	Furnace / AC	1851	kWh	28.6	MBtu	52.5	MBtu	**19.8%**
3	GA Atlanta	Metal frame, double pane	Furnace / AC	2437	kWh	41.8	MBtu	73.6	MBtu	--
3	GA Atlanta	with exterior clear panel	Furnace / AC	2395	kWh	31.4	MBtu	61.8	MBtu	16.1%
3	GA Atlanta	with interior clear panel	Furnace / AC	2362	kWh	30.1	MBtu	60.0	MBtu	18.5%
3	GA Atlanta	with exterior low-e panel	Furnace / AC	2248	kWh	26.7	MBtu	55.0	MBtu	**25.3%**
3	GA Atlanta	with interior low-e panel	Furnace / AC	2310	kWh	25	MBtu	53.8	MBtu	**26.9%**
3	GA Atlanta	with exterior solar-E panel	Furnace / AC	1891	kWh	30.5	MBtu	55.0	MBtu	**25.3%**
3	GA Atlanta	with exterior clear panel, worst case mounting	Furnace / AC	2332	kWh	35.5	MBtu	65.5	MBtu	11.0%
3	GA Atlanta	with exterior low-e panel, worst case mounting	Furnace / AC	2173	kWh	32.8	MBtu	60.8	MBtu	17.5%
3	GA Atlanta	with exterior solar-E panel, worst case mountin	Furnace / AC	1882	kWh	36.2	MBtu	61.1	MBtu	17.0%
3	TX Fort Worth	Wood frame, single pane	Furnace / AC	4526	kWh	40.2	MBtu	95.9	MBtu	--
3	TX Fort Worth	with exterior clear panel	Furnace / AC	3911	kWh	22.9	MBtu	69.9	MBtu	27.1%
3	TX Fort Worth	with interior clear panel	Furnace / AC	3893	kWh	21.9	MBtu	68.6	MBtu	28.4%
3	TX Fort Worth	with exterior low-e panel	Furnace / AC	3639	kWh	19.6	MBtu	63.2	MBtu	**34.1%**
3	TX Fort Worth	with interior low-e panel	Furnace / AC	3788	kWh	17.3	MBtu	62.4	MBtu	**34.9%**
3	TX Fort Worth	with exterior solar-E panel	Furnace / AC	3173	kWh	22.8	MBtu	61.3	MBtu	**36.0%**
3	TX Fort Worth	Wood frame, double pane	Furnace / AC	4139	kWh	26.5	MBtu	76.5	MBtu	--
3	TX Fort Worth	with exterior clear panel	Furnace / AC	3811	kWh	22.3	MBtu	68.1	MBtu	10.9%
3	TX Fort Worth	with interior clear panel	Furnace / AC	3860	kWh	21.1	MBtu	67.4	MBtu	11.9%
3	TX Fort Worth	with exterior low-e panel	Furnace / AC	3545	kWh	19.5	MBtu	62.0	MBtu	**18.9%**
3	TX Fort Worth	with interior low-e panel	Furnace / AC	3719	kWh	17.6	MBtu	61.9	MBtu	**19.0%**
3	TX Fort Worth	with exterior solar-E panel	Furnace / AC	3099	kWh	22.7	MBtu	60.4	MBtu	**21.0%**
3	TX Fort Worth	Metal frame, double pane	Furnace / AC	4085	kWh	33.7	MBtu	83.7	MBtu	--
3	TX Fort Worth	with exterior clear panel	Furnace / AC	3916	kWh	24.8	MBtu	72.0	MBtu	13.9%
3	TX Fort Worth	with interior clear panel	Furnace / AC	3847	kWh	23.7	MBtu	70.1	MBtu	16.3%
3	TX Fort Worth	with exterior low-e panel	Furnace / AC	3633	kWh	20.9	MBtu	64.5	MBtu	**22.9%**
3	TX Fort Worth	with interior low-e panel	Furnace / AC	3693	kWh	19.4	MBtu	63.6	MBtu	**24.0%**
3	TX Fort Worth	with exterior solar-E panel	Furnace / AC	3174	kWh	24.2	MBtu	62.9	MBtu	**24.9%**
3	TX Fort Worth	with exterior clear panel, worst case mounting	Furnace / AC	3864	kWh	28.3	MBtu	75.3	MBtu	10.1%
3	TX Fort Worth	with exterior low-e panel, worst case mounting	Furnace / AC	3599	kWh	26.1	MBtu	69.8	MBtu	16.6%
3	TX Fort Worth	with exterior solar-E panel, worst case mountin	Furnace / AC	3213	kWh	29.1	MBtu	68.7	MBtu	18.0%

Climate Zone	Location	Window	Cooling Cost ($)	Heating Cost ($)	Total Cost ($)	Energy cost savings	% energy cost savings	Simple payback	Payback for low-e
3	GA Atlanta	Wood frame, single pane	319.44	752.61	1046.31	--	--	--	
3	GA Atlanta	with exterior clear panel	296.56	448.5	714.37	$331.94	31.7%	11.2	
3	GA Atlanta	with interior clear panel	295.79	431.65	697.41	$348.90	33.3%	10.7	
3	GA Atlanta	with exterior low-e panel	282.26	387	636.48	$409.83	**39.2%**	**10.1**	**5.4**
3	GA Atlanta	with interior low-e panel	293.15	345.64	609.2	$437.11	**41.8%**	**9.5**	**4.8**
3	GA Atlanta	with exterior solar-E panel	251.68	443.41	652.08	$394.23	**37.7%**	**10.5**	**6.7**
3	GA Atlanta	Wood frame, double pane	306.9	512.13	790.87	--	--	--	
3	GA Atlanta	with exterior clear panel	290.4	436.17	694.01	$96.86	12.2%	38.4	
3	GA Atlanta	with interior clear panel	294.14	415.1	678.44	$112.43	14.2%	33.1	
3	GA Atlanta	with exterior low-e panel	276.32	385.59	627.15	$163.72	**20.7%**	**25.3**	**6.3**
3	GA Atlanta	with interior low-e panel	288.31	350.61	607.9	$182.97	**23.1%**	**22.6**	**6.0**
3	GA Atlanta	with exterior solar-E panel	247.61	439.92	643.53	$147.34	**18.6%**	**28.1**	**8.3**
3	GA Atlanta	Metal frame, double pane	300.19	641.88	909.95	--	--	--	
3	GA Atlanta	with exterior clear panel	295.35	482.59	746.04	$163.91	18.0%	22.7	
3	GA Atlanta	with interior clear panel	292.27	462.82	722.64	$187.31	20.6%	19.8	
3	GA Atlanta	with exterior low-e panel	281.38	410.92	658.2	$251.75	**27.7%**	**16.4**	**4.8**
3	GA Atlanta	with interior low-e panel	286.55	383.82	637.92	$272.03	**29.9%**	**15.2**	**5.0**
3	GA Atlanta	with exterior solar-E panel	251.35	468.29	676.3	$233.65	**25.7%**	**17.7**	**6.0**
3	GA Atlanta	with exterior clear panel, worst case mounting	290.84	545.65	802.17	$107.78	11.8%	34.5	
3	GA Atlanta	with exterior low-e panel, worst case mounting	276.43	504.6	743.63	$166.32	18.3%	24.9	
3	GA Atlanta	with exterior solar-E panel, worst case mounting	251.13	556.72	763.74	$146.21	16.1%	28.3	
3	TX Fort Worth	Wood frame, single pane – Natural Gas Heating	506.77	428.25	926.11	--	--	--	
3	TX Fort Worth	with exterior clear panel	454.3	243.84	674.05	$252.06	27.2%	14.7	
3	TX Fort Worth	with interior clear panel	452.32	233.7	661.93	$264.18	28.5%	14.1	
3	TX Fort Worth	with exterior low-e panel	430.1	208.7	608.99	$317.12	**34.2%**	**13.0**	**6.5**
3	TX Fort Worth	with interior low-e panel	438.9	184.69	601.37	$324.74	**35.1%**	**12.7**	**6.9**
3	TX Fort Worth	with exterior solar-E panel	389.84	243.27	592.3	$333.81	**36.0%**	**12.4**	**5.1**
3	TX Fort Worth	Wood frame, double pane – Natural Gas Heating	473.44	281.95	737.24	--	--	--	
3	TX Fort Worth	with exterior clear panel	445.94	237.07	656.28	$80.96	11.0%	45.9	
3	TX Fort Worth	with interior clear panel	450.01	224.35	648.95	$88.29	12.0%	42.1	
3	TX Fort Worth	with exterior low-e panel	422.29	208.14	598.09	$139.15	**18.9%**	**29.7**	**7.2**
3	TX Fort Worth	with interior low-e panel	433.73	187.2	596.29	$140.95	**19.1%**	**29.4**	**8.0**
3	TX Fort Worth	with exterior solar-E panel	384.12	241.32	582.21	$155.03	**21.0%**	**26.7**	**5.7**
3	TX Fort Worth	Metal frame, double pane – Natural Gas Heating	471.35	359.18	808.53	--	--	--	
3	TX Fort Worth	with exterior clear panel	455.51	264.11	694.87	$113.66	14.1%	32.7	
3	TX Fort Worth	with interior clear panel	449.46	252.17	675.34	$133.19	16.5%	27.9	
3	TX Fort Worth	with exterior low-e panel	430.1	222.96	622.59	$185.94	**23.0%**	**22.2**	**5.8**
3	TX Fort Worth	with interior low-e panel	435.6	206.56	612.79	$195.74	**24.2%**	**21.1**	**6.7**
3	TX Fort Worth	with exterior solar-E panel	390.83	257.73	606.87	$201.66	**24.9%**	**20.5**	**4.8**
3	TX Fort Worth	with exterior clear panel, worst case mounting	452.32	301.24	726.28	$82.25	10.2%	45.2	
3	TX Fort Worth	with exterior low-e panel, worst case mounting	428.12	277.95	673.84	$134.69	16.7%	30.7	
3	TX Fort Worth	with exterior solar-E panel, worst case mounting	395.01	309.63	663.06	$145.47	18.0%	28.4	

Climate Zone	Location	Window	HVAC	Whole House Cooling		Whole House Heating		Source Energy		% source energy savings
3	TX Fort Worth	Wood frame, single pane	Heat pump / AC	4526	kWh	3079	kWh	87.3	MBtu	--
3	TX Fort Worth	with exterior clear panel	Heat pump / AC	3911	kWh	1856	kWh	66.2	MBtu	24.2%
3	TX Fort Worth	with interior clear panel	Heat pump / AC	3893	kWh	1788	kWh	65.2	MBtu	25.3%
3	TX Fort Worth	with exterior low-e panel	Heat pump / AC	3639	kWh	1603	kWh	60.2	MBtu	**31.1%**
3	TX Fort Worth	with interior low-e panel	Heat pump / AC	3788	kWh	1455	kWh	60.2	MBtu	**31.1%**
3	TX Fort Worth	with exterior solar-E panel	Heat pump / AC	3173	kWh	1777	kWh	56.8	MBtu	**34.9%**
3	TX Fort Worth	Wood frame, double pane	Heat pump / AC	4139	kWh	2125	kWh	71.9	MBtu	--
3	TX Fort Worth	with exterior clear panel	Heat pump / AC	3811	kWh	1802	kWh	64.4	MBtu	10.4%
3	TX Fort Worth	with interior clear panel	Heat pump / AC	3860	kWh	1725	kWh	64.1	MBtu	10.8%
3	TX Fort Worth	with exterior low-e panel	Heat pump / AC	3545	kWh	1591	kWh	59.0	MBtu	**18.0%**
3	TX Fort Worth	with interior low-e panel	Heat pump / AC	3719	kWh	1468	kWh	59.6	MBtu	**17.2%**
3	TX Fort Worth	with exterior solar-E panel	Heat pump / AC	3099	kWh	1757	kWh	55.8	MBtu	**22.5%**
3	TX Fort Worth	Metal frame, double pane	Heat pump / AC	4085	kWh	2603	kWh	76.8	MBtu	--
3	TX Fort Worth	with exterior clear panel	Heat pump / AC	3916	kWh	1991	kWh	67.8	MBtu	11.7%
3	TX Fort Worth	with interior clear panel	Heat pump / AC	3847	kWh	1905	kWh	66.0	MBtu	14.0%
3	TX Fort Worth	with exterior low-e panel	Heat pump / AC	3633	kWh	1693	kWh	61.2	MBtu	**20.4%**
3	TX Fort Worth	with interior low-e panel	Heat pump / AC	3693	kWh	1594	kWh	60.7	MBtu	**20.9%**
3	TX Fort Worth	with exterior solar-E panel	Heat pump / AC	3174	kWh	1868	kWh	57.9	MBtu	**24.6%**
3	TX Fort Worth	with exterior clear panel, worst case mounting	Heat pump / AC	3864	kWh	2219	kWh	69.8	MBtu	9.0%
3	TX Fort Worth	with exterior low-e panel, worst case mounting	Heat pump / AC	3599	kWh	2044	kWh	64.8	MBtu	15.6%
3	TX Fort Worth	with exterior solar-E panel, worst case mountin	Heat pump / AC	3213	kWh	2199	kWh	62.1	MBtu	19.1%
2	AZ Phoenix	Wood frame, single pane	Heat pump / AC	7873	kWh	948	kWh	101.3	MBtu	--
2	AZ Phoenix	with exterior clear panel	Heat pump / AC	6707	kWh	477	kWh	82.5	MBtu	18.6%
2	AZ Phoenix	with interior clear panel	Heat pump / AC	6673	kWh	453	kWh	81.8	MBtu	19.2%
2	AZ Phoenix	with exterior low-e panel	Heat pump / AC	6197	kWh	375	kWh	75.5	MBtu	**25.5%**
2	AZ Phoenix	with interior low-e panel	Heat pump / AC	6363	kWh	320	kWh	76.7	MBtu	**24.2%**
2	AZ Phoenix	with exterior solar-E panel	Heat pump / AC	5552	kWh	450	kWh	68.9	MBtu	**32.0%**
2	AZ Phoenix	Wood frame, double pane	Heat pump / AC	7089	kWh	572	kWh	88.0	MBtu	--
2	AZ Phoenix	with exterior clear panel	Heat pump / AC	6550	kWh	457	kWh	80.5	MBtu	8.5%
2	AZ Phoenix	with interior clear panel	Heat pump / AC	6608	kWh	424	kWh	80.7	MBtu	8.2%
2	AZ Phoenix	with exterior low-e panel	Heat pump / AC	6042	kWh	370	kWh	73.6	MBtu	**16.3%**
2	AZ Phoenix	with interior low-e panel	Heat pump / AC	6268	kWh	324	kWh	75.7	MBtu	**14.0%**
2	AZ Phoenix	with exterior solar-E panel	Heat pump / AC	5442	kWh	444	kWh	67.6	MBtu	**23.2%**
2	AZ Phoenix	Metal frame, double pane	Heat pump / AC	7305	kWh	804	kWh	93.1	MBtu	--
2	AZ Phoenix	with exterior clear panel	Heat pump / AC	6888	kWh	550	kWh	85.4	MBtu	8.3%
2	AZ Phoenix	with interior clear panel	Heat pump / AC	6768	kWh	517	kWh	83.6	MBtu	10.2%
2	AZ Phoenix	with exterior low-e panel	Heat pump / AC	6223	kWh	408	kWh	76.1	MBtu	**18.2%**
2	AZ Phoenix	with interior low-e panel	Heat pump / AC	6298	kWh	372	kWh	76.6	MBtu	**17.7%**
2	AZ Phoenix	with exterior solar-E panel	Heat pump / AC	5596	kWh	487	kWh	69.8	MBtu	**25.0%**
2	AZ Phoenix	with exterior clear panel, worst case mounting	Heat pump / AC	6903	kWh	646	kWh	86.7	MBtu	6.9%
2	AZ Phoenix	with exterior low-e panel, worst case mounting	Heat pump / AC	6299	kWh	549	kWh	78.6	MBtu	15.6%
2	AZ Phoenix	with exterior solar-E panel, worst case mountin	Heat pump / AC	5779	kWh	624	kWh	73.5	MBtu	21.0%

Climate Zone	Location	Window	Cooling Cost ($)	Heating Cost ($)	Total Cost ($)	Energy cost savings	% energy cost savings	Simple payback	Payback for low-e
3	TX Fort Worth	Wood frame, single pane – Heat Pump Heating	506.77	338.69	836.55	--	--	--	
3	TX Fort Worth	with exterior clear panel	454.3	204.16	634.37	$202.18	24.2%	18.4	
3	TX Fort Worth	with interior clear panel	452.32	196.68	624.91	$211.64	25.3%	17.6	
3	TX Fort Worth	with exterior low-e panel	430.1	176.33	576.62	$259.93	**31.1%**	**15.9**	**7.3**
3	TX Fort Worth	with interior low-e panel	438.9	160.05	576.73	$259.82	**31.1%**	**15.9**	**8.7**
3	TX Fort Worth	with exterior solar-E panel	389.84	195.47	544.5	$292.05	**34.9%**	**14.2**	**4.7**
3	TX Fort Worth	Wood frame, double pane – Heat Pump Heating	473.44	233.75	689.04	--	--	--	
3	TX Fort Worth	with exterior clear panel	445.94	198.22	617.43	$71.61	10.4%	51.9	
3	TX Fort Worth	with interior clear panel	450.01	189.75	614.35	$74.69	10.8%	49.8	
3	TX Fort Worth	with exterior low-e panel	422.29	175.01	564.96	$124.08	**18.0%**	**33.3**	**8.0**
3	TX Fort Worth	with interior low-e panel	433.73	161.48	570.57	$118.47	**17.2%**	**34.9**	**9.6**
3	TX Fort Worth	with exterior solar-E panel	384.12	193.27	534.16	$154.88	**22.5%**	**26.7**	**5.0**
3	TX Fort Worth	Metal frame, double pane – Heat Pump Heating	471.35	286.33	735.68	--	--	--	
3	TX Fort Worth	with exterior clear panel	455.51	219.01	649.77	$85.91	11.7%	43.3	
3	TX Fort Worth	with interior clear panel	449.46	209.55	632.72	$102.96	14.0%	36.1	
3	TX Fort Worth	with exterior low-e panel	430.1	186.23	585.86	$149.82	**20.4%**	**27.6**	**6.6**
3	TX Fort Worth	with interior low-e panel	435.6	175.34	581.57	$154.11	**20.9%**	**26.8**	**8.2**
3	TX Fort Worth	with exterior solar-E panel	390.83	205.48	554.62	$181.06	**24.6%**	**22.8**	**4.4**
3	TX Fort Worth	with exterior clear panel, worst case mounting	452.32	244.09	669.13	$66.55	9.0%	55.9	
3	TX Fort Worth	with exterior low-e panel, worst case mounting	428.12	224.84	620.73	$114.95	15.6%	36.0	
3	TX Fort Worth	with exterior solar-E panel, worst case mounting	395.01	241.89	595.32	$140.36	19.1%	29.5	
2	AZ Phoenix	Wood frame, single pane	961.86	107.12	996.77	--	--	--	
2	AZ Phoenix	with exterior clear panel	857.78	53.9	811.79	$184.98	18.6%	20.1	
2	AZ Phoenix	with interior clear panel	854.17	51.19	805.24	$191.53	19.2%	19.4	
2	AZ Phoenix	with exterior low-e panel	808.74	42.37	742.63	$254.14	**25.5%**	**16.3**	**6.1**
2	AZ Phoenix	with interior low-e panel	824.33	36.16	755.18	$241.59	**24.2%**	**17.1**	**8.4**
2	AZ Phoenix	with exterior solar-E panel	749.64	50.85	678.23	$318.54	**32.0%**	**13.0**	**3.1**
2	AZ Phoenix	Wood frame, double pane	893.04	64.64	865.7	--	--	--	
2	AZ Phoenix	with exterior clear panel	844.11	51.64	791.79	$73.91	8.5%	50.3	
2	AZ Phoenix	with interior clear panel	849.31	47.91	794.61	$71.09	8.2%	52.3	
2	AZ Phoenix	with exterior low-e panel	795.75	41.81	724.56	$141.14	**16.3%**	**29.3**	**6.2**
2	AZ Phoenix	with interior low-e panel	816.42	36.61	744.89	$120.81	**14.0%**	**34.2**	**8.4**
2	AZ Phoenix	with exterior solar-E panel	740.04	50.17	665.12	$200.58	**23.2%**	**20.6**	**3.3**
2	AZ Phoenix	Metal frame, double pane	905.81	90.85	916.31	--	--	--	
2	AZ Phoenix	with exterior clear panel	866.6	62.15	840.49	$75.82	8.3%	49.0	
2	AZ Phoenix	with interior clear panel	855.52	58.42	823.2	$93.11	10.2%	39.9	
2	AZ Phoenix	with exterior low-e panel	812.58	46.1	749.3	$167.01	**18.2%**	**24.8**	**4.6**
2	AZ Phoenix	with interior low-e panel	819.14	42.04	753.71	$162.60	**17.7%**	**25.4**	**6.0**
2	AZ Phoenix	with exterior solar-E panel	754.73	55.03	687.38	$228.93	**25.0%**	**18.1**	**2.7**
2	AZ Phoenix	with exterior clear panel, worst case mounting	869.08	73	853.04	$63.27	6.9%	58.7	
2	AZ Phoenix	with exterior low-e panel, worst case mounting	822.3	62.04	773.83	$142.48	15.5%	29.0	
2	AZ Phoenix	with exterior solar-E panel, worst case mounting	773.03	70.51	723.54	$192.77	21.0%	21.5	

Climate Zone	Location	Window	HVAC	Whole House Cooling		Whole House Heating		Source Energy		% source energy savings
2	FL Jacksonville	Wood frame, single pane	Heat pump / AC	4599	kWh	1504	kWh	70.1	MBtu	--
2	FL Jacksonville	with exterior clear panel	Heat pump / AC	4022	kWh	823	kWh	55.6	MBtu	20.6%
2	FL Jacksonville	with interior clear panel	Heat pump / AC	4004	kWh	786	kWh	55.0	MBtu	21.5%
2	FL Jacksonville	with exterior low-e panel	Heat pump / AC	3774	kWh	680	kWh	51.1	MBtu	**27.0%**
2	FL Jacksonville	with interior low-e panel	Heat pump / AC	3947	kWh	594	kWh	52.1	MBtu	**25.6%**
2	FL Jacksonville	with exterior solar-E panel	Heat pump / AC	3274	kWh	804	kWh	46.8	MBtu	**33.2%**
2	FL Jacksonville	Wood frame, double pane	Heat pump / AC	4234	kWh	968	kWh	59.7	MBtu	--
2	FL Jacksonville	with exterior clear panel	Heat pump / AC	3918	kWh	798	kWh	54.1	MBtu	9.3%
2	FL Jacksonville	with interior clear panel	Heat pump / AC	3975	kWh	749	kWh	54.2	MBtu	9.2%
2	FL Jacksonville	with exterior low-e panel	Heat pump / AC	3673	kWh	674	kWh	49.9	MBtu	**16.4%**
2	FL Jacksonville	with interior low-e panel	Heat pump / AC	3866	kWh	602	kWh	51.3	MBtu	**14.1%**
2	FL Jacksonville	with exterior solar-E panel	Heat pump / AC	3202	kWh	794	kWh	45.9	MBtu	**23.2%**
2	FL Jacksonville	Metal frame, double pane	Heat pump / AC	4143	kWh	1255	kWh	62.0	MBtu	--
2	FL Jacksonville	with exterior clear panel	Heat pump / AC	4005	kWh	900	kWh	56.3	MBtu	9.1%
2	FL Jacksonville	with interior clear panel	Heat pump / AC	3938	kWh	855	kWh	55.0	MBtu	11.2%
2	FL Jacksonville	with exterior low-e panel	Heat pump / AC	3753	kWh	735	kWh	51.5	MBtu	**16.9%**
2	FL Jacksonville	with interior low-e panel	Heat pump / AC	3826	kWh	675	kWh	51.7	MBtu	**16.6%**
2	FL Jacksonville	with exterior solar-E panel	Heat pump / AC	3269	kWh	857	kWh	47.4	MBtu	**23.6%**
2	FL Jacksonville	with exterior clear panel, worst case mounting	Heat pump / AC	3928	kWh	1039	kWh	57.0	MBtu	8.0%
2	FL Jacksonville	with exterior low-e panel, worst case mounting	Heat pump / AC	3679	kWh	940	kWh	53.0	MBtu	14.4%
2	FL Jacksonville	with exterior solar-E panel, worst case mountin	Heat pump / AC	3281	kWh	1052	kWh	49.8	MBtu	19.7%
2	TX Houston	Wood frame, single pane	Furnace / AC	4865	kWh	25.1	MBtu	83.3	MBtu	--
2	TX Houston	with exterior clear panel	Furnace / AC	4236	kWh	14.1	MBtu	64.0	MBtu	23.1%
2	TX Houston	with interior clear panel	Furnace / AC	4218	kWh	13.5	MBtu	63.2	MBtu	24.1%
2	TX Houston	with exterior low-e panel	Furnace / AC	3976	kWh	11.8	MBtu	58.5	MBtu	**29.7%**
2	TX Houston	with interior low-e panel	Furnace / AC	4145	kWh	10.4	MBtu	58.9	MBtu	**29.2%**
2	TX Houston	with exterior solar-E panel	Furnace / AC	3461	kWh	13.6	MBtu	54.6	MBtu	**34.4%**
2	TX Houston	Wood frame, double pane	Furnace / AC	4475	kWh	16.4	MBtu	69.3	MBtu	--
2	TX Houston	with exterior clear panel	Furnace / AC	4132	kWh	13.6	MBtu	62.3	MBtu	10.1%
2	TX Houston	with interior clear panel	Furnace / AC	4185	kWh	12.9	MBtu	62.1	MBtu	10.3%
2	TX Houston	with exterior low-e panel	Furnace / AC	3874	kWh	11.7	MBtu	57.3	MBtu	**17.4%**
2	TX Houston	with interior low-e panel	Furnace / AC	4071	kWh	10.6	MBtu	58.3	MBtu	**15.8%**
2	TX Houston	with exterior solar-E panel	Furnace / AC	3391	kWh	13.4	MBtu	53.6	MBtu	**22.7%**
2	TX Houston	Metal frame, double pane	Furnace / AC	4380	kWh	21	MBtu	73.2	MBtu	--
2	TX Houston	with exterior clear panel	Furnace / AC	4230	kWh	15.3	MBtu	65.3	MBtu	10.9%
2	TX Houston	with interior clear panel	Furnace / AC	4160	kWh	14.5	MBtu	63.6	MBtu	13.1%
2	TX Houston	with exterior low-e panel	Furnace / AC	3959	kWh	12.6	MBtu	59.2	MBtu	**19.1%**
2	TX Houston	with interior low-e panel	Furnace / AC	4031	kWh	11.7	MBtu	59.1	MBtu	**19.3%**
2	TX Houston	with exterior solar-E panel	Furnace / AC	3460	kWh	14.4	MBtu	55.5	MBtu	**24.3%**
2	TX Houston	with exterior clear panel, worst case mounting	Furnace / AC	4156	kWh	17.4	MBtu	66.7	MBtu	8.9%
2	TX Houston	with exterior low-e panel, worst case mounting	Furnace / AC	3892	kWh	15.9	MBtu	62.1	MBtu	15.3%
2	TX Houston	with exterior solar-E panel, worst case mountin	Furnace / AC	3480	kWh	17.5	MBtu	59.1	MBtu	19.3%

Climate Zone	Location	Window	Cooling Cost ($)	Heating Cost ($)	Total Cost ($)	Energy cost savings	% energy cost savings	Simple payback	Payback for low-e
2	FL Jacksonville	Wood frame, single pane	555.34	172.96	701.85	--	--	--	
2	FL Jacksonville	with exterior clear panel	503.59	94.65	557.18	$144.67	20.6%	25.7	
2	FL Jacksonville	with interior clear panel	501.75	90.39	550.85	$151.00	21.5%	24.6	
2	FL Jacksonville	with exterior low-e panel	479.67	78.2	512.21	$189.64	**27.0%**	**21.8**	**9.3**
2	FL Jacksonville	with interior low-e panel	494.96	68.31	522.22	$179.63	**25.6%**	**23.0**	**14.7**
2	FL Jacksonville	with exterior solar-E panel	434.93	92.46	468.97	$232.88	**33.2%**	**17.8**	**4.8**
2	FL Jacksonville	Wood frame, double pane	523.6	111.32	598.23	--	--	--	
2	FL Jacksonville	with exterior clear panel	494.5	91.77	542.34	$55.89	9.3%	66.5	
2	FL Jacksonville	with interior clear panel	498.87	86.14	543.27	$54.96	9.2%	67.6	
2	FL Jacksonville	with exterior low-e panel	471.62	77.51	499.91	$98.32	**16.4%**	**42.1**	**9.9**
2	FL Jacksonville	with interior low-e panel	488.52	69.23	513.82	$84.41	**14.1%**	**49.0**	**14.3**
2	FL Jacksonville	with exterior solar-E panel	429.07	91.31	459.54	$138.69	**23.2%**	**29.8**	**5.1**
2	FL Jacksonville	Metal frame, double pane	516.47	144.33	620.78	--	--	--	
2	FL Jacksonville	with exterior clear panel	503.13	103.5	564.08	$56.70	9.1%	65.6	
2	FL Jacksonville	with interior clear panel	497.26	98.33	551.2	$69.58	11.2%	53.4	
2	FL Jacksonville	with exterior low-e panel	479.32	84.53	516.13	$104.65	**16.9%**	**39.5**	**8.8**
2	FL Jacksonville	with interior low-e panel	485.76	77.63	517.62	$103.16	**16.6%**	**40.1**	**12.5**
2	FL Jacksonville	with exterior solar-E panel	435.05	98.56	474.5	$146.28	**23.6%**	**28.3**	**4.7**
2	FL Jacksonville	with exterior clear panel, worst case mounting	497.61	119.49	571.21	$49.57	8.0%	75.0	
2	FL Jacksonville	with exterior low-e panel, worst case mounting	474.61	108.1	531.19	$89.59	14.4%	46.2	
2	FL Jacksonville	with exterior solar-E panel, worst case mounting	437.58	120.98	498.3	$122.48	19.7%	33.8	
2	TX Houston	Wood frame, single pane – Natural Gas Heating	543.95	267.73	802.88	--	--	--	
2	TX Houston	with exterior clear panel	490.49	149.64	615.6	$187.28	23.3%	19.8	
2	TX Houston	with interior clear panel	488.07	143.31	607.29	$195.59	24.4%	19.0	
2	TX Houston	with exterior low-e panel	466.95	125.82	563.18	$239.70	**29.9%**	**17.3**	**8.0**
2	TX Houston	with interior low-e panel	480.81	111.02	566.97	$235.91	**29.4%**	**17.5**	**10.4**
2	TX Houston	with exterior solar-E panel	422.29	144.65	525.36	$277.52	**34.6%**	**14.9**	**4.7**
2	TX Houston	Wood frame, double pane – Natural Gas Heating	511.06	174.6	666.85	--	--	--	
2	TX Houston	with exterior clear panel	481.58	144.77	599.29	$67.56	10.1%	55.0	
2	TX Houston	with interior clear panel	485.65	136.96	597.31	$69.54	10.4%	53.5	
2	TX Houston	with exterior low-e panel	458.04	124.83	550.97	$115.88	**17.4%**	**35.7**	**8.7**
2	TX Houston	with interior low-e panel	474.87	112.44	560.25	$106.60	**16.0%**	**38.8**	**11.3**
2	TX Houston	with exterior solar-E panel	416.13	143.06	516.07	$150.78	**22.6%**	**27.4**	**5.0**
2	TX Houston	Metal frame, double pane – Natural Gas Heating	504.79	223.32	705.12	--	--	--	
2	TX Houston	with exterior clear panel	490.27	162.47	627.77	$77.35	11.0%	48.1	
2	TX Houston	with interior clear panel	484.11	154.74	612.34	$92.78	13.2%	40.1	
2	TX Houston	with exterior low-e panel	466.07	134.46	569.95	$135.17	**19.2%**	**30.6**	**7.3**
2	TX Houston	with interior low-e panel	471.9	124.78	568.19	$136.93	**19.4%**	**30.2**	**9.5**
2	TX Houston	with exterior solar-E panel	422.4	153.65	534.25	$170.87	**24.2%**	**24.2**	**4.5**
2	TX Houston	with exterior clear panel, worst case mounting	485.32	185.61	642.77	$62.35	8.8%	59.6	
2	TX Houston	with exterior low-e panel, worst case mounting	461.67	168.86	596.98	$108.14	15.3%	38.3	
2	TX Houston	with exterior solar-E panel, worst case mounting	424.93	186.81	569.61	$135.51	19.2%	30.5	

Climate Zone	Location	Window	HVAC	Whole House Cooling		Whole House Heating		Source Energy		% source energy savings
2	TX Houston	Wood frame, single pane	Heat pump / AC	4865	kWh	2035	kWh	79.2	MBtu	--
2	TX Houston	with exterior clear panel	Heat pump / AC	4236	kWh	1214	kWh	62.6	MBtu	21.0%
2	TX Houston	with interior clear panel	Heat pump / AC	4218	kWh	1168	kWh	61.8	MBtu	21.9%
2	TX Houston	with exterior low-e panel	Heat pump / AC	3976	kWh	1034	kWh	57.5	MBtu	**27.4%**
2	TX Houston	with interior low-e panel	Heat pump / AC	4145	kWh	941	kWh	58.4	MBtu	**26.3%**
2	TX Houston	with exterior solar-E panel	Heat pump / AC	3461	kWh	1131	kWh	52.7	MBtu	**33.4%**
2	TX Houston	Wood frame, double pane	Heat pump / AC	4475	kWh	1400	kWh	67.5	MBtu	--
2	TX Houston	with exterior clear panel	Heat pump / AC	4132	kWh	1174	kWh	60.9	MBtu	9.7%
2	TX Houston	with interior clear panel	Heat pump / AC	4185	kWh	1124	kWh	61.0	MBtu	9.6%
2	TX Houston	with exterior low-e panel	Heat pump / AC	3874	kWh	1020	kWh	56.2	MBtu	**16.7%**
2	TX Houston	with interior low-e panel	Heat pump / AC	4071	kWh	947	kWh	57.6	MBtu	**14.6%**
2	TX Houston	with exterior solar-E panel	Heat pump / AC	3391	kWh	1117	kWh	51.8	MBtu	**23.3%**
2	TX Houston	Metal frame, double pane	Heat pump / AC	4380	kWh	1714	kWh	70.0	MBtu	--
2	TX Houston	with exterior clear panel	Heat pump / AC	4230	kWh	1301	kWh	63.5	MBtu	9.2%
2	TX Houston	with interior clear panel	Heat pump / AC	4160	kWh	1245	kWh	62.1	MBtu	11.3%
2	TX Houston	with exterior low-e panel	Heat pump / AC	3959	kWh	1091	kWh	58.0	MBtu	**17.1%**
2	TX Houston	with interior low-e panel	Heat pump / AC	4031	kWh	1030	kWh	58.1	MBtu	**17.0%**
2	TX Houston	with exterior solar-E panel	Heat pump / AC	3460	kWh	1191	kWh	53.4	MBtu	**23.7%**
2	TX Houston	with exterior clear panel, worst case mounting	Heat pump / AC	4156	kWh	1453	kWh	64.4	MBtu	8.0%
2	TX Houston	with exterior low-e panel, worst case mounting	Heat pump / AC	3892	kWh	1322	kWh	59.9	MBtu	14.4%
2	TX Houston	with exterior solar-E panel, worst case mountin	Heat pump / AC	3480	kWh	1413	kWh	56.2	MBtu	19.7%
1	FL Miami	Wood frame, single pane	Heat pump / AC	7514	kWh	60	kWh	87.0	MBtu	--
1	FL Miami	with exterior clear panel	Heat pump / AC	6627	kWh	18	kWh	76.3	MBtu	12.3%
1	FL Miami	with interior clear panel	Heat pump / AC	6589	kWh	16	kWh	75.8	MBtu	12.8%
1	FL Miami	with exterior low-e panel	Heat pump / AC	6265	kWh	11	kWh	72.1	MBtu	**17.1%**
1	FL Miami	with interior low-e panel	Heat pump / AC	6489	kWh	8	kWh	74.6	MBtu	**14.2%**
1	FL Miami	with exterior solar-E panel	Heat pump / AC	5527	kWh	14	kWh	63.6	MBtu	**26.8%**
1	FL Miami	Wood frame, double pane	Heat pump / AC	6968	kWh	24	kWh	80.3	MBtu	--
1	FL Miami	with exterior clear panel	Heat pump / AC	6485	kWh	16	kWh	74.6	MBtu	7.0%
1	FL Miami	with interior clear panel	Heat pump / AC	6550	kWh	14	kWh	75.4	MBtu	6.1%
1	FL Miami	with exterior low-e panel	Heat pump / AC	6120	kWh	11	kWh	70.4	MBtu	**12.3%**
1	FL Miami	with interior low-e panel	Heat pump / AC	6388	kWh	8	kWh	73.4	MBtu	**8.5%**
1	FL Miami	with exterior solar-E panel	Heat pump / AC	5423	kWh	14	kWh	62.4	MBtu	**22.2%**
1	FL Miami	Metal frame, double pane	Heat pump / AC	6829	kWh	40	kWh	78.9	MBtu	--
1	FL Miami	with exterior clear panel	Heat pump / AC	6612	kWh	21	kWh	76.2	MBtu	3.4%
1	FL Miami	with interior clear panel	Heat pump / AC	6510	kWh	19	kWh	75.0	MBtu	4.9%
1	FL Miami	with exterior low-e panel	Heat pump / AC	6240	kWh	13	kWh	71.8	MBtu	**9.0%**
1	FL Miami	with interior low-e panel	Heat pump / AC	6338	kWh	11	kWh	72.9	MBtu	**7.6%**
1	FL Miami	with exterior solar-E panel	Heat pump / AC	5525	kWh	16	kWh	63.6	MBtu	**19.3%**
1	FL Miami	with exterior clear panel, worst case mounting	Heat pump / AC	6507	kWh	27	kWh	75.0	MBtu	4.9%
1	FL Miami	with exterior low-e panel, worst case mounting	Heat pump / AC	6141	kWh	21	kWh	70.8	MBtu	10.3%
1	FL Miami	with exterior solar-E panel, worst case mountin	Heat pump / AC	5538	kWh	26	kWh	63.9	MBtu	19.0%

Climate Zone	Location	Window	Cooling Cost ($)	Heating Cost ($)	Total Cost ($)	Energy cost savings	% energy cost savings	Simple payback	Payback for low-e
2	TX Houston	Wood frame, single pane – Heat Pump Heating	543.95	223.85	759	--	--	--	
2	TX Houston	with exterior clear panel	490.49	133.54	599.5	$159.50	21.0%	23.3	
2	TX Houston	with interior clear panel	488.07	128.48	592.46	$166.54	21.9%	22.3	
2	TX Houston	with exterior low-e panel	466.95	113.74	551.1	$207.90	**27.4%**	**19.9**	**8.7**
2	TX Houston	with interior low-e panel	480.81	103.51	559.46	$199.54	**26.3%**	**20.7**	**12.7**
2	TX Houston	with exterior solar-E panel	422.29	124.41	505.12	$253.88	**33.4%**	**16.3**	**4.5**
2	TX Houston	Wood frame, double pane – Heat Pump Heating	511.06	154	646.25	--	--	--	
2	TX Houston	with exterior clear panel	481.58	129.14	583.66	$62.59	9.7%	59.4	
2	TX Houston	with interior clear panel	485.65	123.64	583.99	$62.26	9.6%	59.7	
2	TX Houston	with exterior low-e panel	458.15	112.2	538.34	$107.91	**16.7%**	**38.3**	**9.3**
2	TX Houston	with interior low-e panel	474.87	104.17	551.98	$94.27	**14.6%**	**43.9**	**13.1**
2	TX Houston	with exterior solar-E panel	416.13	122.87	495.88	$150.37	**23.3%**	**27.5**	**4.8**
2	TX Houston	Metal frame, double pane – Heat Pump Heating	504.79	188.54	670.34	--	--	--	
2	TX Houston	with exterior clear panel	490.27	143.11	608.41	$61.93	9.2%	60.0	
2	TX Houston	with interior clear panel	484.11	136.95	594.55	$75.79	11.3%	49.0	
2	TX Houston	with exterior low-e panel	466.07	120.01	555.5	$114.84	**17.1%**	**36.0**	**7.9**
2	TX Houston	with interior low-e panel	471.9	113.3	556.71	$113.63	**17.0%**	**36.4**	**11.1**
2	TX Houston	with exterior solar-E panel	422.4	131.01	511.61	$158.73	**23.7%**	**26.1**	**4.3**
2	TX Houston	with exterior clear panel, worst case mounting	485.32	159.83	616.99	$53.35	8.0%	69.7	
2	TX Houston	with exterior low-e panel, worst case mounting	461.67	145.42	573.54	$96.80	14.4%	42.7	
2	TX Houston	with exterior solar-E panel, worst case mounting	424.93	155.43	538.23	$132.11	19.7%	31.3	
1	FL Miami	Wood frame, single pane	874.12	6.9	871.01	--	--	--	
1	FL Miami	with exterior clear panel	795.8	2.07	764.18	$106.83	12.3%	34.8	
1	FL Miami	with interior clear panel	792.35	1.84	759.58	$111.43	12.8%	33.4	
1	FL Miami	with exterior low-e panel	761.88	1.27	721.75	$149.26	**17.1%**	**27.7**	**9.9**
1	FL Miami	with interior low-e panel	781.66	0.92	747.16	$123.85	**14.2%**	**33.4**	**33.8**
1	FL Miami	with exterior solar-E panel	695.87	1.61	637.22	$233.79	**26.8%**	**17.7**	**3.3**
1	FL Miami	Wood frame, double pane	827.2	2.76	804.08	--	--	--	
1	FL Miami	with exterior clear panel	783.5	1.84	747.62	$56.46	7.0%	65.8	
1	FL Miami	with interior clear panel	789.13	1.61	754.86	$49.22	6.1%	75.5	
1	FL Miami	with exterior low-e panel	749.46	1.27	705.07	$99.01	**12.3%**	**41.8**	**9.9**
1	FL Miami	with interior low-e panel	773.26	0.92	735.54	$68.54	**8.5%**	**60.4**	**21.7**
1	FL Miami	with exterior solar-E panel	686.78	1.61	625.26	$178.82	**22.2%**	**23.1**	**3.4**
1	FL Miami	Metal frame, double pane	816.5	4.6	789.94	--	--	--	
1	FL Miami	with exterior clear panel	795.92	2.42	762.8	$27.14	3.4%	137.0	
1	FL Miami	with interior clear panel	786.83	2.19	750.84	$39.10	4.9%	95.1	
1	FL Miami	with exterior low-e panel	760.5	1.5	719.1	$70.84	**9.0%**	**58.4**	**9.6**
1	FL Miami	with interior low-e panel	769.35	1.27	730.14	$59.80	**7.6%**	**69.2**	**20.3**
1	FL Miami	with exterior solar-E panel	695.98	1.84	637.22	$152.72	**19.3%**	**27.1**	**3.3**
1	FL Miami	with exterior clear panel, worst case mounting	788.33	3.11	751.42	$38.52	4.9%	96.5	
1	FL Miami	with exterior low-e panel, worst case mounting	753.71	2.42	708.64	$81.30	10.3%	50.9	
1	FL Miami	with exterior solar-E panel, worst case mounting	697.82	2.99	639.86	$150.08	19.0%	27.6	

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